The Sibley Journal of Engineering

SIBLEY COLLEGE, CORNELL UNIVERSITY

Published by

THE SIBLEY JOURNAL OF ENGINEERING, Inc

Ithaca, N. Y.

FOUNDED 1885 — INCORPORATED 1916

JUSTIN F. WAIT - - - - - - - - *President*
WILLIAM N. BARNARD - - - - - *Vice-President*
EARL G. HENDERSON - - - - - *Secretary-Treasurer*
CLARENCE A. PEIRCE - - - - - *Second Vice-President*

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States and Canada, $2.00 a year — **Foreign, $2.25 a year; Payable in advance**

Remit by postoffice or express money orders, bank checks, drafts or registered letters made payable to THE SIBLEY JOURNAL OF ENGINNEERIG, INC. Money in letters at sender's risk. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 5th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.,
ITHACA, N. Y.

INDEX

VOL. XXXI

(OCTOBER, 1916 TO SEPTEMBER, 1917, INCLUSIVE)

Cr.

SUBJECT MATTER

CONTRIBUTORS

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY *Copyright by the Sibley Journal of Engineering, Inc., 1916* ITHACA, N. Y.

Vol. XXXI OCTOBER, 1916 No. 1

Irving Porter Church

As this issue goes through the press Cornell University—that great mechanism for moulding men—starts on another yearly run but this time minus one of its most important and useful units. There will never be another "Poppy" Church.

Professor I. P. Church needs no introduction to the former students of Sibley College, especially to the older men many of whom were his pupils. The following short biography of Professor Church is given that we may all know a few of the important events of his life. No writer could find words to describe even a small part of the good which Professor Church has done or to express the great esteem which the engineering profession has for him.

Irving Porter Church was born on July 22, 1851, at Ansonia, Connecticut, but the family moved in 1857 to Newburgh, New York, where his father, Dr. Samuel P. Church, long and successfully practiced the profession of medicine. Thus the boy was brought up among the "Highlands" and received his primary and preparatory training in the public schools of Newburgh except for a final year in the Riverview Military Academy at Poughkeepsie.

He entered Cornell with the second four-year class in 1869 and received the degree of C.E. in 1873, since which time he has been continuously engaged in teaching. For the first three years he taught mathematics, principally, in a preparatory school near Philadelphia, Pennsylvania, but the remaining forty years have been spent in the service of his alma mater, beginning with his appointment as Assistant Professor of Civil Engineering in 1876. His title was changed to Associate Professor in 1891 and in 1892 he was made Professor of Applied Mechanics and Hydraulics, a chair which he has filled continuously since that time. He was granted the degree of M.C.E. in 1878.

Professor Church is best known to the engineering profession as the author of "Mechanics of Engineering" which appeared in 1890 as the result of a consolidation of his "Statics and Dynamics for Engineering Students" 1886, "Mechanics of Materials," 1887, and "Hydraulics and Pneumatics" 1889. This work was supplemented by his "Notes and Examples in Mechanics" in 1892. Since that time, in addition to numerous contributions to technical periodicals and the proceedings of learned and scientific societies, he has written "Diagrams of Mean Velocity of Water in Open Channels," 1902, "Hydraulic Motors," 1905 and "Mechanics of Internal Work," 1910, besides making several revisions of his earlier works.

To his students of the past forty years, Professor Church is equally well known for his remarkable ability as a teacher. This quality, as well as excellence in authorship, is due to his mastery of his subject and power of presenting it in a clear, logical manner and in its simplest terms, combined with rare ingenuity in devising problems to illustrate principles and their applications. The excellent reputation of the colleges of engineering of Cornell and the success of their graduates are due in no small degree to the thorough training given so many years in the fundamental subject of mechanics under his charge.

As a man, Professor Church possesses rare personal charm, being modest and unassuming, imbued with high ideals, gifted with ability in art and music and keenly interested in all human affairs. Thus his influence both in the class room and out have always been inspiring to his students and colleagues.

Professor Church is a member of the Honorary Scientific Society of Sigma Xi and the Society for the Promotion of Engineering Education and an Associate of the American Society of Civil Engineers.

Our Departure

With the present issue of the JOURNAL the 1915–16 Editing Board of the SIBLEY JOURNAL OF ENGINEERING ceases to exist. Since it assumed charge of the publication of the JOURNAL a year ago this time it has strived incessantly to better the service which the JOURNAL had been rendering Sibley College and the alumni of Sibley College.

It succeeded in publishing more editorial material than any previous Board and in addition issued a list of former students of Sibley College. This list has been appreciated by many of our alumni who have taken the trouble to express that appreciation by somewhat flattering letters.

By no means, however, has the Board lived up to the ideals which it set for itself at the beginning of the year. It barely approximated the imaginary criterion which was held before it all through the year.

The new Editing Board of the JOURNAL will consist of three Juniors and five Sophomores. The majority of these men will, however, be experienced men and they will all work in close co-operation with the Associate Editors. During the reorganization of the JOURNAL which occurred several months ago a new method was devised by which the faculty and the undergraduate members of the JOURNAL Board are able to co-operate with one another more closely than heretofore.

"MINING THE FROZEN GRAVELS OF THE ARTIC"

By DR. HENRY M. PAYNE*

(In a preceding article the writer outlined the development of the Klondyke and gave a general description of the methods employed and the research work which is being carried on there.)

Conditions in the Siberian goldfields are entirely different. The labor situation, facilities for ingress and egress, and the manner in which the gold is recovered, are all crude and makeshift, notwithstanding the fact that the yield per cubic yard is greatly in excess of that in the Klondyke.

Geographically and topographically, the two regions are not dissimilar. The principal watersheds of the Lena goldfield, are the Vitim, Bodaibo, Engazhimo, Nakatami, Vacha, Jouia, and Nigri rivers, all of which reach the Arctic through the Lena River, whose source is on the west side of a high range of mountains rising abruptly on the west shore of Lake Baikal.

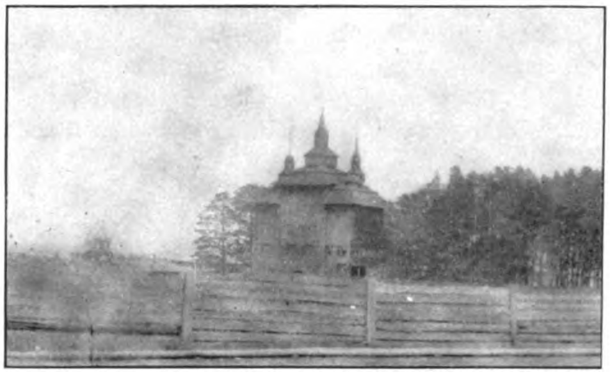


Fig. 1. Old Russian Church at Kirinsk, Siberia, built about the year 1300. Windows were of native eisenglass.

Fig. 2 Typical Siberian Town.

Devonian limestones, capped by red sandstones, with occasional folds, are characteristic for 2,000 miles down the Lena River.

Farther north, granite knobs have intruded themselves upward through the Devonian strata, and as the goldfield is approached along the Vitim River and the mouth of the Bodaibo, a giant upheaval, not unlike that of the Klondyke, has taken place, and the Silurian and Cambrian rocks become evident.

In elevation above sea level, there is little difference between the Klondyke and the Bodaibo regions. The Dome, which crowns the divide between the Klondyke and Indian River watersheds, has an elevation of 4,250 feet, while the general average of the Siberian summits is 4,000 feet, Mt. Longdor, the highest, being 6,900 feet.

As many as six terraces or benches may be clearly traced, but the former and present stream beds appear to have little relevance, alluvial gold being found in many of the non-eroded portions throughout a vertical distance of 1,500 feet, in any of the horizons.

Attention has been called by Purington to the fact that extensive basins exist at the heads of these streams, and the alluvial deposit is from 100 to 250 feet in thickness, while at the mouths of the streams, canons and gorges are usual, and the alluvium is only 20 feet to 35 feet thick.

The history of the discovery of gold in Siberia is interesting. About 1750 a peasant discovered gold on the site of the present Beresovsky mine in the North Urals. This was in the reign of the Empress Ekaterina. The peasant was imprisoned for life, for "undue curiosity."

In 1861 Roukhloff propounded a theory that no river flowing south could have gold in an east tributary. The Verni is an east tributary of the Nigri. A Tartar servant found a nugget and Roukhloff gave him a beating for stealing. The Tartar then went to one Vacielievsky, working on the Hhomolhho, and Vacielievsky staked the claim. In a distance of less than two miles on this stream, there were subsequently taken out $15,830,400 worth of gold.

Entrance to the gold fields is by Trans-Siberian Railway to Irkutsk, on the west shore of Lake Baikal. For 240 miles from Irkutsk, a fair automobile road has been built. From Kachug to Zhigolovo, in high water, the trip may be made by rowboat, a distance of eighty miles. In low water, a team of horses and native wagon, or "telega" is essential.

In the spring floods, the Lena River steamers can ascend to Zhigolovo. The balance of the year, the trip is made to the head of navigation, which may be anywhere from 500 to 700 miles, by rowboat.

Food is secured at the various native settlements enroute, and men to row the boat downstream, or horses to tow it against the current, are obtained at

*Formerly Professor of Mining, West Virginia University. Consulting Mining Engineer, New York City.

the Government post stations, located from 25 to 35 miles apart. Small river steamers and barges are in service on the lower Lena River, and on the Vitim.

From Bodaibo to Nadeshdinsky, at the forks of the Bodaibo River, a distance of sixty miles, the Lenskoie Gold Mining Company has built a railroad.

When one considers the difficulties of the trip today and then recalls that in the early 60's prospectors wended their way by sled over the ice in winter, a distance of 5,000 miles from Petrograd, he can only feel amazed at their energy.

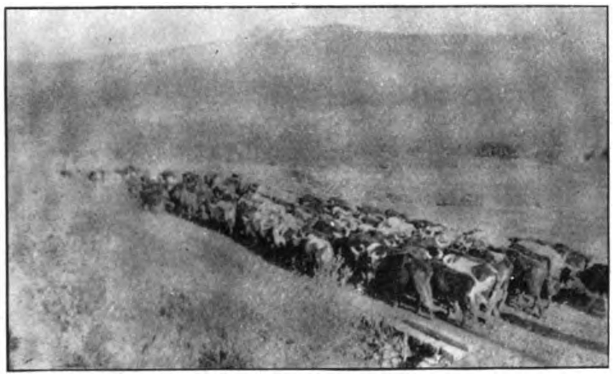


FIG. 3. CATTLE ON THE HOOF, BEING DRIVEN INTO THE SIBERIAN GOLDFIELDS FROM MANCHURIA.

Branch lines at various routes have been proposed, to connect with the Trans-Siberian Railway; also a steamer line to the north end of Lake Baikal and Chaussèe from there to Bodaibo, but none of these plans seem likely of immediate installation.

About 8,000 employees are on the direct payroll of the mining company, and at least 30,000 people are dependent directly or indirectly upon the mining operations.

The mining world first became interested in this field when the rich Blagoveschensky Claim on the Nakatami River was at its greatest production. In one year, by open cutting, 1,000,000 cubic yards were taken out and $18,000,000 recovered. This averaged about $12 per square foot of bed rock. In a distance of twenty miles, the output of this valley has been about $100,000,000.

FIG. 4. NATIVE RUSSIAN HARROW.

The total recorded output of the Lenskoie properties is in excess of $200,000,000, to which must be added a considerable amount of gold stolen and sold illicitly.

In this connection, the attitude of the Russian Government toward the stealing of gold, is unique. The workmen do not consider it wrong to pick up nuggets in the workings and to keep them, calling them "God-sent."

The Government regulations regarding the hiring of laborers stipulate that the "rate of pay due to the workmen for gold so taken, is to be specified in the contract." This undoubtedly gives the workman a certain right of ownership, and makes it difficult to sue him for picking up nuggets, and any agreements without this clause are considered illegal.

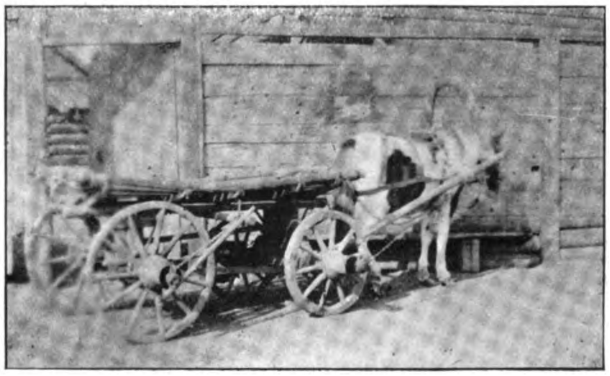


FIG. 5. TELEGA OR NATIVE WAGON.

Any effort to cope with this evil is an uneven struggle of one honest man against several hundred expert thieves, whose actions are sanctioned by established custom and partly protected by governmental regulations.

The Feodosievsky claim, on the upper Bodaibo, has a pay-streak from 800 to 1200 feet wide, with from 100 to 125 feet of overburden, which necessitates the sinking of shafts and regular underground mining.

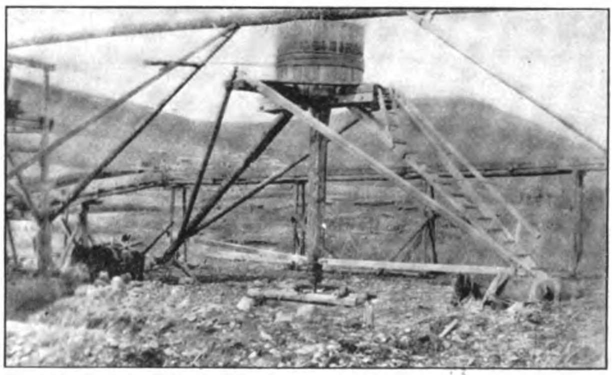


FIG. 6. HORSE-OPERATED WHIM FOR HOISTING.

In September, 1914, the gold at this operation began to grow very coarse, and nuggets from $24 to $170 in value, were found. To avoid loss by theft, a washing plant was installed underground, and during the succeeding seven months, the average values recovered per cubic yard were $164.62, $278.30, $132.06, $219.50, $204.13, $141.40, and $128.50 respectively, or an average of $182.36 per cubic yard.

In one working place, the values have averaged, for a period of over a month, $746.75 per cubic yard. In all these faces, a watchman is kept for each miner, to prevent theft. The pay-streak at this point is from eight feet to ten feet six inches in thickness.

So far as the writer is aware, this is the richest known goldfield in the world today.

Fig. 7. Native Residence on the Nakatami River, Built Out of Rocks from the Tailing Piles.

The average of the whole field for many miles up and down the river, is given as about $8.50 per cubic yard. When comparison is made with Klondyke values, running from .09 to .43 per cubic yard, one marvels that even greater profits have not been made. But up to the present time, the operation has been over-staffed with a disproportionate number of clerks, book-keepers, foremen, watchmen, drivers, servants, etc., and a lavish outlay for carriages and equipment countenanced throughout the administration, so that nothing less than a veritable El Dorado could have supported the incredible overhead expense.

No similar area in the Klondyke or Siberia has ever developed such a high production or such continuous pay-streak.

Until the winter of 1914–15, the gravel mined during the winter was dumped into carts or box sleds

Fig. 8. The Famous Blagoveschensky.

holding about six cubic feet, at the top of the shaft and removed to the winter dump. In the spring, it was thawed and picked loose and re-carted to the washing plant. Such rehandling was not only expensive but afforded unlimited opportunity for theft of nuggets.

Winter washing is now being done at a few of the operations, using enclosed heated washing plants. The introduction of dredging on a large scale will eliminate this problem, except at the Feodosievsky, and a few minor operations where bedrock lies too deep for dredging.

It is interesting to note that in the Klondyke, values

Fig. 9. Partial View of Timber Yard at Bodaibo, Where the Logs are Taken from the Vitim River and Stored Until Needed at the Mines.

are found in the crevices of broken bed rock for four or six feet in depth, with barren over-burden, while the records of Thorne, who has operated a battery of 40 Keystone drills for some years past, in the Lena, show values extending from the surface, and practically none in bed rock.

Earlier drilling was done with the Empire drill, but on account of boulders, the Keystone has proven cheaper and more satisfactory.

Outlying properties, so far removed from the main operations as to incur prohibitive supervisory cost, are leased. The renting of gold properties is done in Siberia in two ways; either to Tributors or Arendators.

Tributors are individual workmen or groups of workmen, usually without capital, who obtain for a limited time, the privilege of mining a small tract.

Fig. 10. Method of Timbering Underground Workings at Feodosievsky.

The claim owner remains responsible to the Government, pays the taxes, controls the system of working, and has the right to force the tributor to carry on his work according to law.

The Tributor is compelled to deliver the gold to the claim owner for a fixed price, and has usually to pay

a certain amount per day for the privilege of so working.

Arendators are individual persons or companies, having some capital, and operating on a larger scale. The responsibility to the Government remains on the claim owner, but the latter has no control over the exploitation.

Usually, the Arendator is made to deposit a certain sum as a guarantee against any fines or penalties inflicted by the authorities. The agreement states the duration of the lease, royalty on production, with a minimum clause, and the obligatory expenditure for prospecting.

A striking characteristic of the Russian peasant is his prodigality with timber, wherever used. In ordinary structures, three times the necessary logs are requisitioned, and underground from two to three solid banks of vertical posts, touching one another, with two or three caps superimposed, may be found extending mile after mile, along the entries and in the crosscuts and rooms.

Until a year ago, but little effort was made to recover this timber, and this item constituted 40 per cent of the operating cost. At the present time, probably 50 per cent of the timber used, is being ultimately recovered and used again. Old records show that over $15,000,000 worth of timber has been sent down from the head waters of the Vitim and other sources for use on these properties.

Fig. 11. Guarding Rich Working Places.

Fig. 12. The Result of Driving Entries too Wide and of Unsystematic Robbing of Pillars.

It is now proposed to introduce dredging, using large 17 cubic foot bucket, direct connected, electrically operated, elevator dredges of the Klondyke type. Such an innovation would accomplish a variety of purposes. It would recover all the gold now lost, between the surface and the underground operations. It would decrease by at least 6,000, the number of necessary employees, to be transported, housed and provided for. This latter item of general provision includes hospitals, churches, stores, etc.

It would also materially increase the yardage per year and the resulting gold recovery, with a marked decrease in operating cost.

It would eliminate large staffs of clerks, bookkeepers, servants, foremen, supervisors, police, and supernumeraries, with consequent decrease in overhead expense.

It would recover large areas of pillars and auriferous overburden left in old workings. It would enable many low-grade claims to be worked which would otherwise be unavailable under existing methods. It would recover quantities of timber from old workings, which could be utilized in present underground operations too deep for dredging.

The power consumed in operating dredges would be much less than that required at present for pumping the water from the mines. Greater than all these combined, would be the absolute elimination of the theft problem, since one trusted employee would effect the clean-ups on the dredges. The amount of gold stolen from the company and bought back by them, under the Employe's Law, approximates $1,500,000 per year.

One of these large dredges, costing about $425,000 at the factory in the United States, can be shipped to Siberia, transported overland, and erected for not to exceed $1,000,000; so that in its first year of operation it should pay for itself through savings from theft.

Power is generated by hydro-electric stations, augmented by steam power when water is low. There is also one producer-gas plant installed, but not in regular use.

Hydraulicking is only done on a limited scale. This is partly due to the fact that most of the prospecting to date, has been in the creek gravels rather than along the benches. Also the boulders are flat and angular, and do not readily lend themselves to sluicing. In addition, a considerable outlay would be required to provide sufficient head for hydraulic purposes, and the water so used, would, of necessity, come from the source of the hydro-electric stations, thus reducing the available power.

The writer is at present engaged in a comparative study of yearly temperature records covering the past eight years in the Klondyke and Siberia. This work has, so far, however, indicated very little difference in the length of either winter or summer seasons, although a wider variation, both in daily and seasonal maxima and minima is apparent in the Klondyke.

In the summer of 1913, the thermometer registered 104° F. in the Klondyke, and in the winter of 1914–15

it recorded—74° F., at Bodaibo, in Siberia. Average winter temperatures of—40° F. are not unusual in either locality, for weeks at a time.

The introduction of dredges, with the consequent advantages mentioned above, the influx of modern methods and correct mining administration, with the elimination of theft and cumbersome red-tape will bring about improved transportation, food, housing, and methods of living, and will make Siberia eventually, as easy of access, as healthful, and as full of opportunities for mineral development as Alaska and the Yukon.

Much of the machinery, and many of the supplies will be "made in America." Unquestionably, American engineers, metallurgists and geologists will shape in a large measure, either through direct connection or in a consulting capacity, the development and destiny of the metal industries of the Arctic Far East.

There, as in the Klondyke, must be evidenced integrity of person and soundness of training. To the engineer, the chemist, the metallurgist, who has these, shall be added professional honor, material success, and an unlimited field for research, out of which will ripen the intimate friendships which make life worth living.

(This is the second of two articles on this subject by Dr. Payne. The first appeared in our September issue.)

THE THEORY AND PRACTICE OF AUTOMOBILE CARBURETION

LENOX R. LOHR, '16

The early history of carburetors is filled with various types in which the mixture of gasoline vapor and air was obtained by bubbling the air through the liquid and entraining the vapor; by passing the incoming air over wicks saturated with gasoline; and by impigning the air on the surface of a puddle of gasoline at the throat of a down curved Venturi tube, and depending upon the velocity to pick up particles of the liquid. Due to the exacting demands of the motor car, the character of the service and the depreciating quality of gasoline, these types have been relegated to obsolescence. The float feed, jet type carbureter is the device in almost universal use now, and to it the present discussion will be restricted.

A carbureter must be a gas plant and not an injector of raw fuel. Its operation must be automatic, regulating the correct proportion of gasoline and air, completely vaporizing the liquid and intimately mixing it with air, irrespective of engine speed, throttle opening, temperature or barometric conditions.

The following requisites are demanded of a good carburetor:

1. *Construction.*—The size and shape should be such that excessive space under the hood will not be occupied. The fuel and warm air should be supplied from any angle, and the throttle and intake connection adjustable to meet individual requirements. The gaskets and packings should be so designed as to permanently prevent leaks, and allow for dissembling the instrument. There should be no delicate or intricate mechanism liable to wear or injury. Adjustment should be easily made by the novice, and a device provided to prevent the adjustment from jarring out.

2. *Operation.*—Strangling and priming devices should be employed to enrich the mixture for easy starting. The motor should idle quietly and economically, and run at the slowest speed of which the machine is capable, without missing. Acceleration should be rapid, smooth and imperceptible. A quick pick-up is often imperative in the congestions of the city, and it adds materially to the average speed of touring. The carbureter must furnish the fuel so that the maximum speed and power of the motor may be developed with the minimum of fuel consumption.

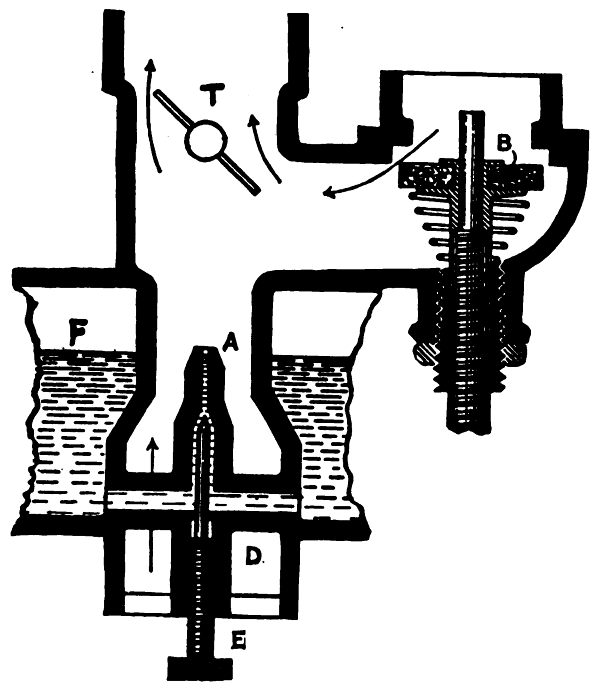


FIG. 1. SIMPLE JET CARBURETOR.

Four conditions of operations:—1. Small opening of throttle and low engine speed. This condition occurs when the motor is idling, when drifting along on level roads or throttling down for city traffic. It occurs with engine speeds below 200 r. p. m. and cars speeds of 5 m. p. h. Adjustment for this condition is easily made.

2. Wide opening of the throttle and low engine speed. This occurs on negotiating a steep grade or pulling a load over a heavy road, on high gear. Under these conditions most carburetors load up and the mixture becomes extremely rich.

3. Small opening of throttle and high engine speed. This occurs when slowing down from high speed or running down hill, in which case, a lean mixture will be drawn into the cylinders.

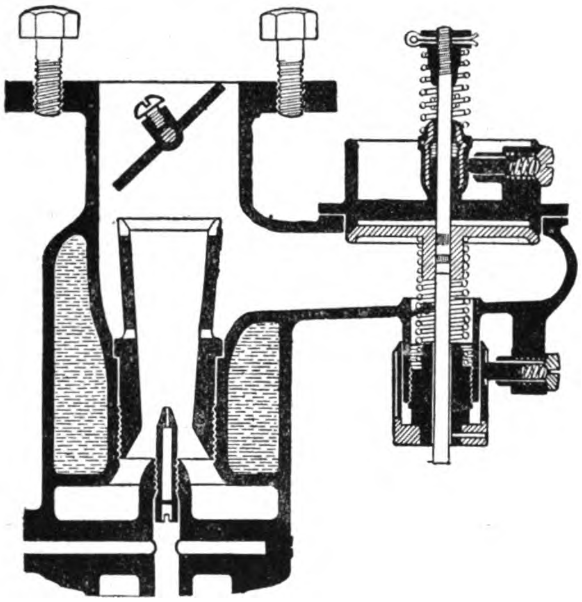


FIG. 2. DUAL SPRING AUXILIARY AIR VALVE.

4. Wide opening of throttle and high engine speed. Met only in racing. Racing drivers prefer a carburetor set for their condition alone.

These combinations represent such a wide variance in operating conditions that the difficulty in making a single adjustment give the maximum economy and power at all times, at once becomes apparent. The various manufacturers have devised ingenious and often complicated expedients in their attempts to solve this problem.

The simple carburetor as in Figure 1 consists of a float chamber F, adjustable needle valve E, gasoline nozzle A, air nozzle D, throttle T, and auxiliary air valve B. The predetermined level of the gasoline in the float chamber should be slightly lower than the top of the gasoline nozzle. It is automatically maintained constant by the float and valve. As the level becomes lower the float falls, and the valve is opened by a series of levers, admitting gasoline from the supply tank until the proper level is reached and the flow cut off. Two pounds per square inch pressure is all that is required in the gasoline supply, but care must be taken, should the tank be located at the rear of the chassis, that sufficient pressure is maintained on ascending steep hills.

The float should be annular and constructed concentric with the spray nozzle, so that inclinations of the car will have the least effect upon the gasoline level, but often structural features demand that the float chambers be offset. The floats were previously made of cork, thoroughly shellaced to prevent saturation, but the best practice now demands a metal float without working joints and only frictional contact with levers.

Each suction stroke of the motor displaces a volume of air which causes a partial vacuum in the intake manifold, the intensity of which depends upon the engine speed. The decrease in pressure causes the gasoline to be ejected from the jet, and if the jet is properly designed, the liquid will be atomized. The tip of the jet is located at the throat of the choke-tube, and the spray is here mixed with the inrushing air. The choke-tube depends upon the Venturi principle, which states that in a continuous tube the quantity of a fluid which passes any section in a given time is constant, but the velocity of flow at the several sections is inversely proportional to the section areas, inducing the highest pressure at the greatest area, and the least pressure at the smallest area. By placing the needle-valve at the throat or smallest section, low pressure and high velocity of incoming air are met. These conditions are ideal for good carburetion since the lower pressure assists in drawing the liquid from the jet, and facilitates the evaporization of the tiny atomized globules issuing from the jet. The high velocity (about a mile a minute) of the inrushing air greatly assists in mixing it with the vapor. A correctly proportioned Venturi tube will hurl the mixture well up in the manifold without precipitation. By means of the needle-valve E (Figure 1) the relation of gasoline to air may be adjusted.

If the mixture is correct for low speeds, in the simple nozzle carburetor, it will become too rich at high speeds. In order to obtain twice the amount of air through the inlet the suction must be more than doubled to compensate for the increased frictional resistance set up by the higher velocity of air passing through the intake. In an actual test the motor suction increased nine times between 400 r. p. m. and

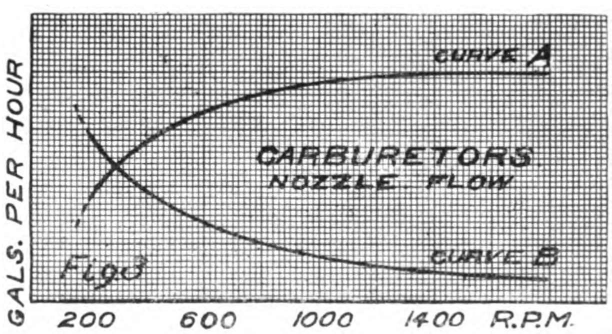


FIG. 3

1600 r. p. m. If the suction is doubled it will cause more than twice the amount of gasoline to flow, and this accounts for the richness of the mixture at the higher speeds. This difficulty has been partly remedied by providing an auxiliary air valve B, (Figure 1) which would be held close by an adjustable spring when the motor was idling. As more power was needed and the intensity of the vacuum increased this valve would be sucked open and would allow air to pass in to the

mixing chamber above the throat of the Venturi. Hence the mixture would not only be diluted, but the velocity of the air through the throat would be decreased and less gasoline would be ejected from the jet.

But this expedient did not fully meet conditions which demand that the correct mixture of gas and air be supplied at all speeds, since a change in the tension on the auxiliary air spring produced a greater proportional effect at low speeds than at high speeds. The next modification consisted in using compound springs on the auxiliary air-valve (see Figure 2). The weaker under spring held the valve closed when idling and with increased speed allowed certain valve openings, until half motor speed was reached. Then the stronger upper spring, which up to this time had not been in touch with the valve, and hence inactive, came into operation. This spring allowed less than a proportional opening of the valve for the higher speeds of the engine.

tube, will automatically supply the correct mixture at all speeds.

In the "Stromberg" carburetor (Figure 5) the gasoline for low speeds is taken from an adjustable spray nozzle located in the Venturi tube through which the hot air passes. A second nozzle is located in the center of the auxiliary air valve and automatically regulated by the opening of this valve, thus supplying the necessary volume of gasoline for high speed and heavy duty work.

In nozzles which supplement each other it is difficult to obtain instantaneous and imperceptible transition. The device which approaches nearest to the theoretical ideal is the cam-operated single-nozzle carburetor. The surface of the cam actuates the needle valve and by adjusting the contour of the cam to meet individual conditions the correct mixture is supplied at all throttle openings. In the "Rayfield" carburetor, (Figure 6,) the axis of a parabolical shaped cam is shifted relative

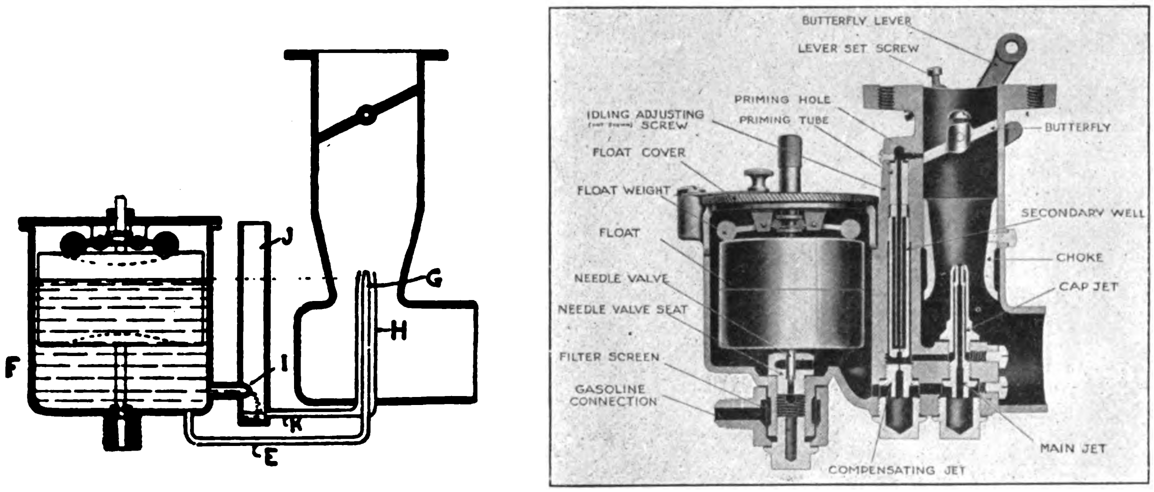


FIG. 4. ZENITH CARBURETOR.

The best solutions of this complex problem, have not varied the air supply relative to a constant flow of gasoline, but have instituted dual gasoline nozzles, or cam mechanism to apportion the correct amount of gasoline to a non-adjustable air supply.

The "Zenith" carburetor operates upon an original and ingenious principle. A simple nozzle is employed which supplies a mixture which becomes constantly richer with increase in speed, as shown in Curve A (Fig. 3). A second, constant flow nozzle has been added, which permits a certain fixed amount of gasoline, as previously determined by opening I (Figure 4,) to flow by gravity into the well J, which is open to the air. The suction at jet H has no effect upon the gravity compensator I, because the suction is destroyed in the open well. A steady rate of flow per unit of time is delivered by this nozzle, irrespective of motor speed, but as the suction increases more air is drawn in, hence the mixture becomes leaner and leaner as shown by Curve B (Figure 3). It is merely necessary to determine the exact sizes of the compound nozzles such, that their combined action will neutralize each other, and when inserted in the correct size choke

to the follower, by an adjusting screw. In the "Schebler" (Figure 7) the cam is flexible and adjustable dials flex the cam at intermediate points, thus completely and accurately determining any mixture of gas and air at any throttle opening.

When an auxiliary air valve is used it is usually non-adjustable and is prevented from fluttering by a dash pot which is simply a piston operating in gasoline.

In all carburetors it is important that the nozzle atomize the gasoline as finely as possible, since it will maintain its globular form up to the point of combustion. The area of these globules exposed to the air is a function of the square of their diameter, but their bulk varies as the cube. Hence, since evaporation is proportional to the exposed surface, more than proportional time is required to gasify the larger spheroids. Smooth running depends primarily upon the complete vaporization of all gasoline passing through the carburetor. The lowering of the pressure, and the application of heat greatly facilitates the evaporation. Heat is required to transform a liquid into a vapor, and it must be supplied when the evaporation is due to a reduction of pressure, and will be

absorbed from the surrounding medium. This phenomenon accounts for the "sweating" of the intake manifold, the temperature of which having been reduced to such a point by the absorption of heat during the vaporization process, that the moisture in

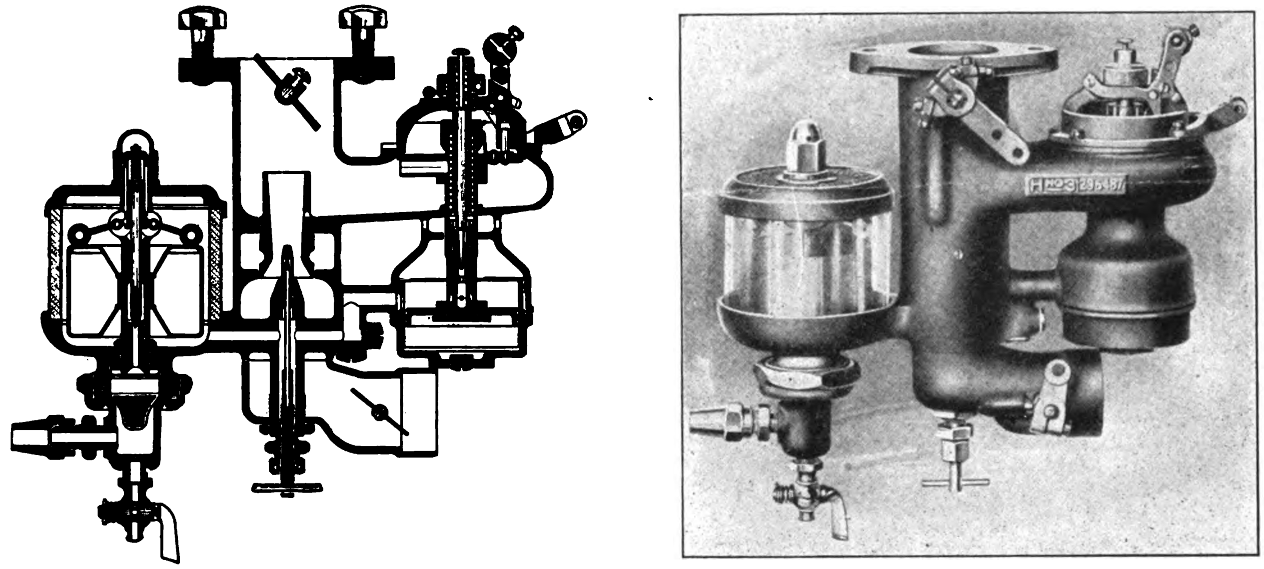


FIG. 5. STROMBERG CARBURETOR.

the air is condensed. Cooling of the mixture causes precipitation, allowing slugs of raw fuel to pass into the motor, especially when using the low grade of fuel now commercially sold. The manifold and mixing chamber should be hot-water jacketed, and pre-heated air supplied. The latter is performed by clamping a stove or housing to the exhaust manifold, just back of the last cylinder, drawing in the warm air from around the exhaust and transferring it by means of flexible metal tubing to the carburetor inlet. If these expedients are resorted to vaporization is likely to be complete, and a more homogeneous and combustible mixture supplied to the motor

There is always more air supplied than the theoretically computed mixture would indicate. The pro-

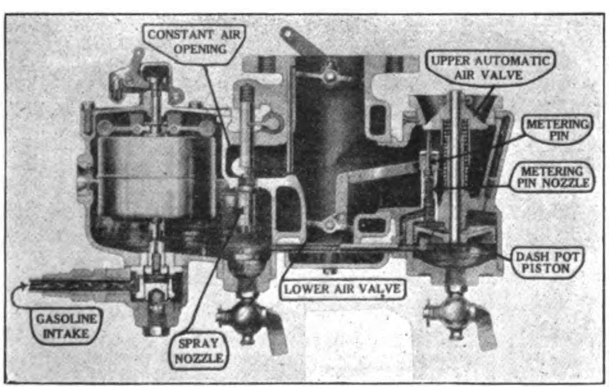


FIG. 6. RAYFIELD CARBURETOR.

portion of supplied to needed air is known as the excess coefficient, varying in value from 1.1 to 1.6, but being usually between 1.3 and 1.4. Since the vapor is never completely mixed with the air, this excess must be furnished to insure that all parts of the vapor are supplied with sufficient air. This prevents unburned gases passing into the exhaust due to the relatively short time allowed for its complete combustion. It is well to remember that less air is required in cold weather than in warm, since a greater quantity of oxygen is contained in the same volume. Also the density of the air sucked in is less with high engine speeds, and will contain less oxygen per unit volume. These are the conditions which are adjusted for in the setting of a carburetor to meet a particular demand, and since a correct adjustment of the instrument is so essential in obtaining a high mileage from the gasoline, and a smooth running, powerful motor, it will be discussed in detail.

Before adjusting a carburetor it should be determined that there is an unobstructed flow of gasoline from the tank to the float chamber; that all gaskets

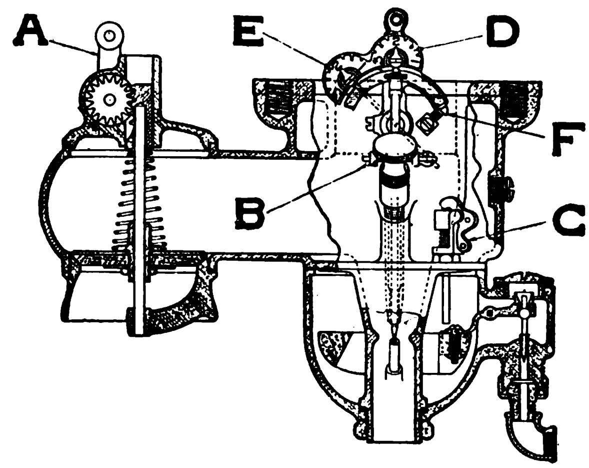


FIG. 7. SCHEBLER CAM MECHANISM.

A. dash control; B. needle valve; C. primer; D. intermediate speed dial; E. high speed dial; F. throttle stop.

and packings are tight and free from air leaks; that compression is good and uniform in each cylinder; that valves and ignition are properly timed, and that there is a fat, hot spark. If there is a dash control it should be set to its down or neutral position, and

the auxiliary air valve must seat firmly. The motor should be thoroughly warmed. Carburetors with adjustments for high and low speed are set, as follows: Retard the spark and throttle down until motor runs slowly. Turn the low speed adjusting screw in the direction that makes the mixture leaner until the motor slows down, then reverse the direction, notch by notch, until the motor idles smoothly. This adjustment in no way affects the high speed adjustment and should not be touched after once being set. In adjusting for high speed, advance the spark about one quarter on the quadrant, then open throttle quickly; if loading or choking occurs the mixture is too rich; if the motor back-fires, the mixture is too lean. The correct adjustment is at the point where one additional notch causes the motor to back-fire. For economy's sake, it is always advisable to set the carburetor at the leanest adjustment which will allow smooth running. In cold weather, or in starting, the mixture may be made richer by the dash adjustment.

If the mixture is too rich, the motor fires with a roll, having a rumbling sound; the exhaust contains heavy charges of black smoke; the motor is sluggish; the spark plugs become rapidly sooted; and after ascending a long hill with the throttle open, the motor does not pick up when the clutch is disengaged. When there is a deficiency of oxygen or too rich a mixture, as may occur in a cold engine at starting, or racing the engine without load, especially in a closed garage, there is great danger of the deadly gas carbonic oxide being generated.

If the mixture is too lean, the car hesitates before picking up speed and kills or back-fires when the throttle is opened quickly. A back-fire is caused by a highly diluted and slowly burning charge. A flame hangs in the cylinder until the opening of the inlet valve on the succeeding stroke, and this flame ignites the charge in the manifold.

In all carburetors if the choke tube is too large the pick-up will be defective, and the motor will run irregularly at low speeds. If the choke tube is too small, the motor will be unable to take a full charge on a fully opened throttle, and hence the maximum speed of which the car is capable will be impossible of attainment. However, the pick-up will be particularly good.

A good test for correct mixture may be made by allowing the engine to run at high speed and slightly depressing the air valve. If the motor speeds up the mixture is too rich, if it slows down the mixture is too lean. A further test may be made if the exhaust flame is visible. A yellow tint indicates too lean a charge, a red tint too rich; the correct adjustment being obtained when the flame is dark blue, verging on violet.

A rich mixture is desirable at low speed and under heavy loads, since it is slower burning and generates a higher mean effective pressure. At high speed when the compression is better and there is less time for leakage and loss of heat by cylinder wall conduction, a lean charge is preferable, but it is important that the spark be well advanced. A slow-burning charge at high speed will maintain a continuance of combustion after the completion of the stroke, and will burn the valves and discharge unburned gas into the exhaust.

All carburetors should be provided with a dash adjustment as conditions must vary, and no carburetor is absolutely automatic. Starting is facilitated, especially in cold weather by a strangling valve in the primary inlet which cuts off the air supply, and is also operated from the dash. The greater vacuum induced, draws a heavy charge from the nozzle and the high vacuum causes it to vaporize readily. A "tickler" which depresses the float and floods the carburetor is also used.

The carburetor should be placed as close to the intake ports as the construction will permit. There should be as few bends as possible in the intake manifold and all projections incident to casting should be carefully removed. An ingeneous device is being used by one of the larger factories to insûre an even charge being delivered to each cylinder. Air pressure is applied at the carburetor end of the manifold and pressure gauges are attached to the cylinder ends. A difference in pressure at these gauges is caused by the surface friction in the different arms of the manifold. The areas of the discharge openings are then enlarged until the pressure is uniform.

In ordering a new carburetor its size should be determined by the area of the intake valve opening since this is the true measure of cylinder capacity. When the stock sizes of carburetors fall between the size determined the smaller should be employed. A carburetor having a larger diameter than the intake manifold should not be used.

Do not expect too much of a carburetor, as the conditions imposed upon it are too severe and at too wide a variance. The standard instruments now on the market represent the maximum attainment in scientifically designed carburetors. But we may expect radical improvements in the future as we have had in the past, and perhaps the instruments are but still in an embryotic stage of their development. Certainly experiments and investigations will continue and the industry would not be surprised to see a successful instrument put on the market embodying an entirely new principle.

RELATION OF PERSONAL HABITS AND CONDUCT TO SUCCESS IN COMMERCIAL WORK

By RALPH B. DAY

Preface

I have been requested to write out for the Sibley Journal the substance of a talk which it has been my habit to give to my various classes in mechanics. The purpose I hope to achieve is to persuade even a very few students to give a little more careful thought to their respective futures. A little sober thinking now, painful as thinking seems to be to some of us, will be far cheaper than sweating blood on some distant later day.

Thus far, my audiences have been sophomores. This has always seemed to me to be a very happy circumstance for the reason that, in general, a sophomore is rather more inclined to listen to advice than is either a junior or a senior. I have been both junior and senior, and not so long since but that I can recall with what distaste I listened to men who thought there were subjects upon which I needed advice. My wish is that each student who reads this article should carefully consider how the various points discussed apply to himself, then accept or reject as seems to him wise.

POPULAR OPINION OF THE NEW GRADUATE

For many years, the new college graduate has been looked upon with a curious blend of distrust and contempt. This feeling is shared alike by the highest official and the lowest workman in the employ of the company which undertakes to absorb one of these unknown quantities. This feeling is not to be wondered at. It is the result of long and costly experience with the general run of graduates from technical institutions.

The existence of this situation offers the beginner a great opportunity to prove his worth or his lack of it. Little is expected of a greenhorn, hence, if certain sterling qualities begin to show themselves and certain other qualities are noticeably absent, early and favorable attention will be the result.

"Swelled head" is, and long has been, an attribute of the average college graduate. Smug self-satisfaction, coupled with its absolute lack of justification, has been a fruitful source of the feeling of distrust which greets the college man on the occasion of his first plunge into commercial work. The graduate would do well to leave behind him all traces of that conceit which the newly acquired diploma so often brings. He is a wise man who refrains from letting his tongue, or his general bearing, flaunt forth his many virtues. Far better it is, and indeed surprisingly near the truth, to assume that every man, however lowly, has some new thing to teach. Not a man in the shop but can do something better, probably far better, than the graduate. Personality and quality of work are the effective talkers. They "make" or "break," and that with absolute impartiality. The process may be slow but it is exceedingly sure.

MAKING FRIENDS

The graduate should, at once, set about the task of making friends of all with whom he comes into contact. The word "task" is used advisedly. Success in this direction is absolutely essential and will require the most painstaking attention.

Suppose, as frequently happens, that the graduate be put in charge of a small gang of men. If the company's work is to be promptly and properly done, the men must feel friendly toward him. The process of obtaining and holding the friendship of certain individual men is often extremely difficult and therefor gives excellent practice in the art. With the growth of the capacity to get effective, cheerful, results out of men, will come appreciation on the part of the employer. This appreciation may not be of the outspoken variety, but it will exist nevertheless.

Suppose a young man fails to maintain the friendly interest of his immediate superior. Some day a man is needed to fill a new position, or one recently vacated. The superior is called into conference and asked if there is a man in his department who, he believes, could properly fill the place. He passes by the young fellow whom he dislikes in favor of another whom he likes better, in spite of the possible fact that his choice may be a man of inferior skill. What is more, this less skillful man, who takes greater interest in his friendly relations with others, will be, in nine cases out of ten, the better choice.

THAT ATROCIOUS TEMPER

Another serious disqualification with which some graduates start, is a temper. Whether it be inherited or painstakingly acquired, it should be suppressed regardless of the resulting internal pressure. Many an excellent opportunity for advancement is shunted around the young fellow with the temper. One of the really sad features of such a case is that the owner of the temper seldom knows that Opportunity approached for a moment, then passed by. Or if he does know, he fails to understand the reason and feels that he has been slighted. The absence of temper will smooth the road to advancement. Its luxuriant presence will raise a barrier well nigh impassable.

CONDUCT UNDER CRITICISM

By some hook or crook, it has come to pass that human nature resents criticism from whatever source. Some men exlpode with anger when criticised. Others lapse into moody silence. Most of them offer excuses even tho guilty. None of these habits is good. Every man going into commercial work, must expect to be criticised. Sometimes the criticism will be made with helpful intent, sometimes in a spirit of anger; sometimes by a superior officer or, again, by an underling. In every case, a careful answer should be made. In the case of the superior, the fiery retort is exceedingly apt to result in a search for another position. With an underling, it loses a friend, and seriously interferes with the effective co-operation which every company needs among its employees.

Every criticism should be dragged forth in private, to be examined carefully. It should be considered with open mind and from every point of view. Almost every search will upturn some fragment of sound justice. A little practice at giving criticisms a hearing, will soon force home a new idea; that it is possible to be wrong while the other man is right. It will be a wholesome idea and one to be cherished.

THE SUPERIOR OFFICER

The superior officer with whom the graduate will come into contact, may be easy to get along with or quite the reverse. In any case, he is worthy of careful study. His varying moods, his likes and dislikes and his methods of work, are all matters of keen interest to the one who must work under him and who wishes to enhance his usefulness to the company. A pleased and approving officer becomes a powerful friend at court when questions of advancement are up for discussion.

After becoming acquainted with the peculiarities of this superior officer, one will be able to find innumerable little ways of facilitating his work. He will seldom notice any individual act. Nevertheless there will slowly, but surely, grow up in him the feeling that here is a man of whose work and personality he approves. This result will be worth all the patience and effort it costs.

NOTES

The graduate who goes into the technical end of engineering, will be called upon to do many kinds of work requiring records and calculations. This at once suggests keeping notes. Every calculation, record, or sketch, however trivial, should be put in a bound notebook. The pages of the book should be consecutively numbered, and every insertion dated. Never under any circumstances, should a mark be made in this notebook without its date. Every addition, subtraction, multiplication, or division, should be made on the pages of the notebook and in such close connection with the work that there can be no possible doubt as to its application. All notes should be in such order that another person could pick up the book and readily trace out all the details of every piece of work done.

Suppose a man designs a piece of machinery. Six months later, the chief comes in and informs him that, in trying to assemble the machine, a certain piece would not go into place by an eighth of an inch. He requests the designer to go over his work and find out where the error arose. The designer has his notebook and can examine every bit of work he put in on the job with the date thereof. If the error is his, the fact will soon become painfully obvious. If his figures are found to be correct, his "alibi" will be complete. Even if the error is found to be his, the existence of the detailed calculations will clear up all doubt as to the cause of the trouble and will greatly moderate the discredit which attaches to such a mistake. Consider for a moment the position of the designer if he had kept no notes. A discussion of such a contingency seems superfluous.

SPECIAL PROBLEMS

Sooner or later, if one is continually on the lookout for such cases, he will stumble upon some special problem the solution of which would materially advance the company's interests. Possibly the problem will be his own independent conception. Here is an opportunity. Very probably he cannot use the company's time in the search for a solution. If not, he should use his own. Let him dispense with a few "movie" evenings and turn out earlier in the morning. He should either definitely fail or find a solution. Even if the company does not see fit to make use of the results, the work will by no means be wasted. It will show that he is both willing and interested.

If one has new ideas which seem good, he should submit them. Of course the first seventy-nine will be turned down, a treatment which must be expected and accepted in perfect good nature. When some of the new ideas begin to be accepted, he will have made a real start on the road to advancement. This kind of practice will sharpen and expand the imagination, a piece of equipment which is absolutely necessary in advanced technical work. Also it will show the company a man's peculiar distinctive qualities. These qualities are the things which eventually will distinguish him and his work from that of other employees.

PERSONAL HABITS

Some of the earlier part of this article might properly have been placed under this heading. I reserve this section for the treatment of a subject which, though an exceedingly sore spot with many, cannot be left out of this discussion. I refer to the alcohol and, to some extent, the smoke and drug habits.

The alcohol habit has been in the world, respectable and respected, for many hundreds of years. Only recently has exact scientific research shown the baleful connection between alcohol and human efficiency. Many young men have been raised in families where alcoholic liquors were used at the family table without

a thought of, and often without knowledge of, the danger inhering in the custom. The purpose of this part of the discussion is not to condemn any individual for his taste for alcohol. It is merely to direct attention to the trouble which will beset the path of the drinker in his effort to keep the pace of modern commercial life.

Practically all the railroads in the country require their men to leave drink alone while on duty. Certain classes of their men may not touch alcohol at any time, either on or off duty. These railroads have learned, by costly experience, that their trains and the lives of passengers cannot be entrusted to the care of men who are, in the slightest degree, under the influence of alcohol.

Great corporations throughout the United States are distinguishing against the man who drinks. Their promotions are made exclusively from the ranks of the non-drinkers. Their own statistics show that the bulk of their accidents are traceable directly or indirectly to the use of alcohol. Why should there be more absences from work on Mondays than on any other day of the week? Why does the peak of the accident curve occur within the first hour after dinner? The corporations have studied these very vital questions, and others of their kind, with the resulting discovery that alcohol is at the bottom of the greater part of the trouble. Their fight against the drinking man is simply a fight for the preservation of themselves and their business.

From a study of some two million insured lives, life insurance companies have discovered that, where one hundred deaths were expected from a given number of the general run of policy holders, saloon-keepers, as a class by themselves, yielded close under two hundred deaths, hard drinkers some one hundred and sixty or seventy deaths, moderate drinkers about one hundred and twenty, against sixty to seventy for total abstainers. These are cold, colorless figures set forth by keen headed business men. These men are interested because the success of their business depends upon how they select their policy holders. "Everyman" is interested because he sees himself in one or other of these roughly outlined groups.

Undoubtedly there are many highly intelligent, commercially successful men who drink and who pooh-pooh the idea that moderate drinking is harmful. The answer is that their number is diminishing with astonishing rapidity; also that the question is no longer an academic one. The evidence is all in and the facts are established. The point of interest to the student is that the young fellow who drinks is going to find himself "up against it" when he gets to bucking the conditions of the modern commercial world.

CONCLUSION

With the average young man, the answer to the question of how to make good in commercial work is to be found in critical, impartial, self-examination. None knows better than a man's own self what his faults are and none should be quicker than he to recognize and attack them. Busy men have little time to waste in removing faults from others. Correction must come from within. Failure to correct means to fall in the rear. The motto "Be thou thine own most exacting taskmaster" is an excellent one to adopt. It fits the case most neatly.

HEATING AND VENTILATION OF ELECTRICAL MACHINERY

By ALEXANDER GRAY*

The losses in electrical machinery are converted into heat causing a rise of temperature at the source of loss. From this point the heat is transmitted to the surrounding air by conduction, convection and radiation.

In order that a flow of heat may take place there must be a temperature difference and the heat flows in the direction of diminishing temperature, so that the highest temperature or what has been called the hot spot of an electrical machine is at the source of loss while the temperature is a minimum at the points where the heat leaves the machine.

Effect of heat on insulating materials. The highest safe temperature at which an electrical machine can be operated continuously depends on the nature of the materials with which it is insulated. Materials such as paper, cotton, as well as the natural gums and resins become brittle under long exposure to temperatures of about 90 degrees C. while temperatures as high as 150 degrees C. may safely be used if the insulation consists of mica.

The effect of heat on insulating materials has been investigated by Rayner† who gives much numerical data to show that while the dielectric strength is not much changed by an increase in temperature the brittleness is greatly increased and the material therefore liable to pulverize, if subjected to vibration.

Limitations of output of electrical machinery. Until recently, electrical machines were limited in output by commutation troubles in the case of direct-current machines and by regulation in the case of alternators, as much as they were limited by heating. The commutation limit has been raised by the use of interpoles while the regulation has been improved by the use of automatic regulators, so that the heating limit has become of greater relative importance.

Free and Forced Convection. Water can be boiled in a paper bag which is held in a bunsen flame, and a postage stamp can be stuck on the fire side of a boiler tube and it will not be scorched. If the temperature of the flue gases is 850°C, and that of the water is 180°C. it will be found that the temperature drop through the tube is only about 4°C. and that most of the drop is between the hot gases and the side of the tube. It would therefore appear that there is something in the nature of a film of gas on one side of the tube and a film of water on the other through which films the heat finds its way with difficulty. If the flue gases are in rapid motion the gas film becomes torn off and the evaporating power of the boiler increased. The above figures illustrate how important the boundary conditions are in heat flow problems and yet the data available on the subject is both scanty and unreliable.

The three problems with which we are concerned in a discussion of the cooling of electrical machinery are:

a. Heat dissipation from a surface by radiation and by free convection.

b. Heat dissipation by forced convection from a body in the stream of air.

c. Heat dissipation from a rotating cylinder.

Radiation and Free Convection. A hot body in air radiates heat to surrounding bodies and this heat does not in any way affect the temperature of the air surrounding the body. Heat also is conducted from the body through the film of surrounding air and this heated air is carried away from the body by convection currents.

The heat radiated may be calculated from the formula

$$W_r = 5.7 \times k \times \left[\left(\frac{T_1}{1000}\right)^4 - \left(\frac{T_2}{1000}\right)^4\right]$$

where T_1 is the temperature of the heated surface in deg. abs. (Centigrade divisions.)

T_2 is the temperature of surrounding bodies in deg. abs.

W_r is the heat radiated per sec. in watts per sq. cm.

k a const. = 1.0 for rough surfaces coated with lamp black
0.72 for oxidized copper
0.62 for oxidized cast iron
0.50 for aluminum paint
0.80 to 1.0 for oils and varnishes no matter of what color.‡

The term black body used in connection with radiation problems is very misleading. The color of a body depends on that part of the energy which the body radiates or reflects in the light part of the spectrum, but has nothing to do with the radiation in the heat part of the spectrum so that, as we find in practice, machines that are painted with yellow varnish run at practically the same temperature as duplicate machines painted with black varnishes.

The heat dissipation by conduction and free convection is more difficult to determine. Langmuir,** arguing from the experimental result that the temperature of a wire carrying a given current is about the same whether the wire is horizontal or vertical states that "it would seem as if conduction was more important than convection or that the heat is conducted

*Head of the Electrical Engineering Dept., Sibley College.

†*Journal of Inst. of Elect. Eng.* Vol. 34, p. 613, May 1905.

‡Langmuir, Trans. Amer. Electrochem. Soc. Vol. 23, p. 299, 1913.

**Physical Review, Vol. 34, p. 401, 1912.

through a film of air and convection currents then carry it away after it has passed through the film."

Langmuir* finds that the film thickness is:

0.43 cm. for a plane surface
0.41 for a cylinder of 10 cm. dia.
0.37 for a cylinder of 2 cm. dia.
0.30 for a cylinder of 0.5 cm. dia.

so that the smaller the diameter of the cylinder the thinner the film and the more heat can the cylinder dissipate per unit of surface for a given rise of surface temperature; this agrees with the results of test.

At the temperature used in electrical machinery the conductivity of air is 2.3×10^{-4} watts per cm. cube per 1°C. difference between the two parallel faces so that the heat lost by free convection may be calculated from the formula

$$W_c = k_a (T_1 - T_2) \ / \ \text{film thickness}$$
$$= 5.3 \times 10^{-4} \text{ watts per sq. cm. per 1 deg. C rise.}$$

Inaccuracy of the Film Theory. While the above theory is a powerful one in the hands of the engineer who has problems of heat dissipation to solve it is advisable to point out here that the results obtained by its use are approximate only. According to the film theory the heat dissipated by convection is proportional to the temperature difference between the surface and the surrounding air while the results of test indicate that the heat dissipation by convection is proportional to the 5/4 power of the temperature difference.

Temperature Rise of Field Coils. In actual machinery the problems of convection are made more difficult by the shapes of the surfaces concerned, also by forced convection which tends to reduce the film thickness.

Different methods by which direct current machines are ventilated are shown in Fig. 1.

In the armature A, air drawn in from both ends of the machine passes through the end connections and through the radial ducts in the core thereby keeping the temperature of the core and windings down to a safe value. Any of the field coils C, D, E or F may be used with this type of armature. The sides M and N of these coils are cooled by air which has passed through the end connections while the face P is cooled by air from the radial ducts. The face Q is poorly ventilated and a duct such as R is of

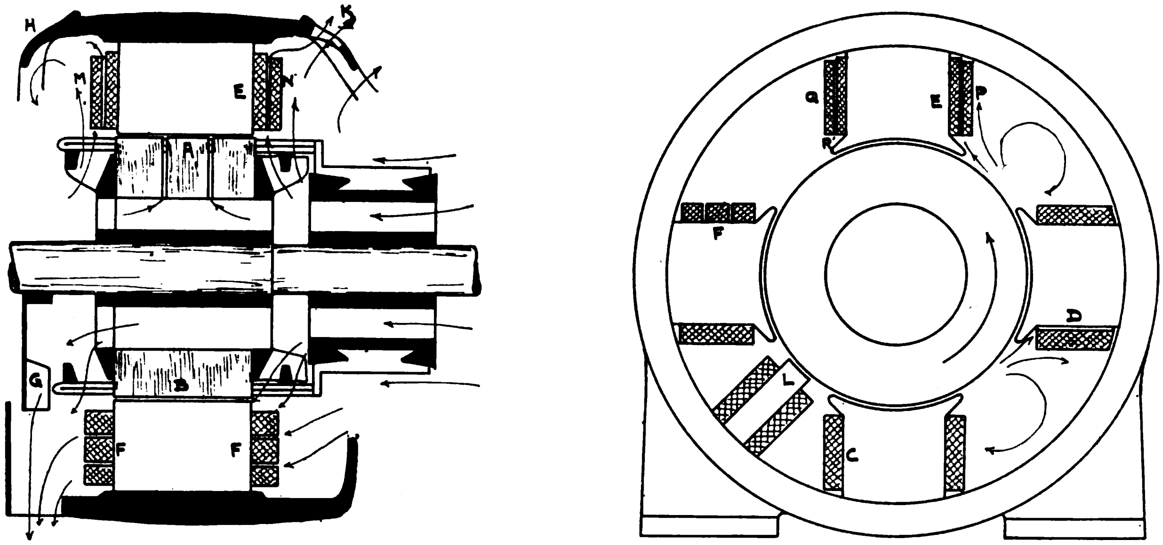


FIG. 1. METHODS OF VENTILATING D. C. MACHINES.

little value unless the machine is expected to run in both directions.

In the armature B, air is drawn axially through the machine by the fan G and, for this type of ventilation, field coils such as F are particularly suited.

Two other construction details in this diagram are of interest. End housings such as H deflect the heated air stream back into the machine and cause the temperature rise to be greater than if ventilated housings such as K had been used. The diagram also shows that the interpoles such as L block off the ventilation from the radial ducts but have not such a great effect when axial ventilation is used, although some recent tests would indicate that the effect of the interpoles in cutting down the ventilation is not as great as one would have expected.

Temperature Gradient through Field Coils. A field coil supported freely in the air is shown in Fig. 2. The depth d is small compared with the mean turn so that the heat is dissipated equally from the inside and the outside surfaces and the maximum temperature is at a, in the centre of the depth. The temperature gradient through the coil is as shown in diagram B.

The maximum temperature of the coil is that which limits the current it can carry without injury to the insulation, but this temperature can be determined only by the use of thermocouples embedded in the coil. The temperature of the external surface may be determined by thermometer while the average temperature of the coil may be determined by the increase in the coil resistance.

If the average temperature and also that of the external surface are known the designer can tell very

*Physical Review, Vol. 34, p. 401, 1912.

closely just what will be the maximum temperature since, as shown above

$(T_{max}-T_{av}) \ / \ (T_{av}-T_{ext}) = 0.5$ theoretically
$=$ a const. for a given type of coil.

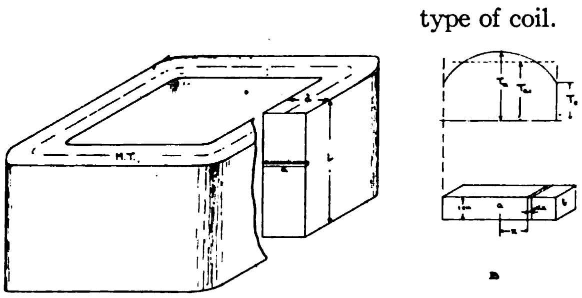
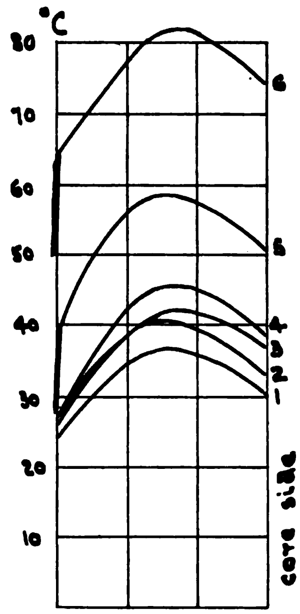


FIG. 2. FIELD COIL FREELY SUPPORTED IN AIR.

(d small compared with L and with M.T.)
let w be the loss per cc. of coil material.
k the thermal conductivity of the coil mass in watts per cm. cube per 1 deg. C.
e the surface emissivity in watts per sq. cm. per 1 deg. C. rise of surface temp.
then the heat crossing the section at x, diagram B, $= wx$ watts.
the temp. drop across thickness dx in deg. C. $= \frac{wxdx}{k}$
the temp. drop between a and b $= \frac{w}{2k}\left(\frac{d}{2}\right)^2$
the average temp. drop between a and b $=$ av value of $\frac{wx^2}{2k} = \frac{w}{6k}\left(\frac{d}{2}\right)^2$
the watts dissipated at surface b $= w\frac{d}{2}$
the temp. rise of surface b $= \frac{w}{e}\frac{d}{2}$
so that T_e the temp. rise of the external surface $= \frac{w}{e}\frac{d}{2}$
T_{max}, the maximum temperature rise $= T_e + \frac{w}{2k}\left(\frac{d}{2}\right)^2$
T_{av}, the average temperature rise $= T_e + \frac{w}{3k}\left(\frac{d}{2}\right)^2$
and $(T_{max} - T_{av}) / (T_{av} - T_e) = \frac{1}{2}$

The temperature rise of field coils depends on many factors. The internal temperature may be reduced by increasing the value of k, the thermal conductivity of the coil mass. This may be accomplished by impregnating the coil with a compound which besides being a better insulator than the air which it replaces is also a better conductor of heat. Impregnation of the coil not only reduces the internal temperature but also reduces that of the external surface of the coil

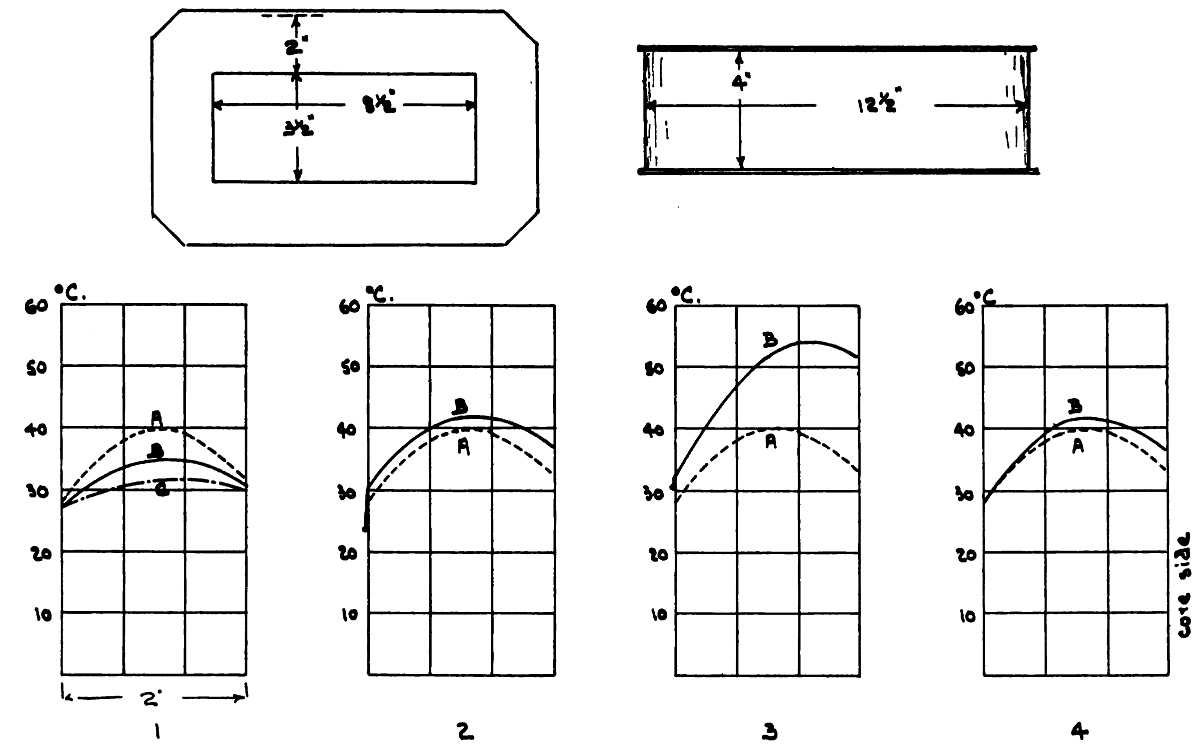


1. Enamelled wire; coil on spool; coil dipped in varnish.
2. Enamelled wire; coil on spool.
3. D. C. C. wire; coil on spool; dipped in varnish.
4. D. C. C. wire; coil on spool.
5. D. C. C. wire; no spool; coil finished with layer of tape.
6. D. C. C. wire; same as 5 but armature fans removed.

(The loss was 65 watts in each case).

FIG. 4. TEMPERATURE TESTS ON FIVE COILS ALL TESTED ON THE SAME MACHINE; THE ARMATURE WAS CARRYING FULL LOAD.

because of the reduction in the coil resistance ad then consequent reduction of the loss in the coil. Actual test results are shown in diagram 1, Fig. 3.



1

Coil on sheet metal former insulated with two thicknesses of presspahn.
A—d. c. c. wire untreated.
B—d. c. c. wire impregnated with white enamel.
C—d. c. c. wire impregnated with brown varnish.

2

Coil on same former as in (1).
A—same as A in (1).
B—coil covered with an external layer of string.

3

A—same as A in (1).
B—Coil has no former and is finished with two layers of tape on the external surface.

4

A—same as A in (1); coil made of 19 layers of 0.058" d. c. c. wire.
B—coil has 38 layers of 0.032" d. c. c. wire (both are untreated).

FIG. 3. TEMPERATURE GRADIENT IN FIELD COILS.

As the cross section of the wire used is increased, the proportion of insulating material in the coil decreases and the thermal conductivity of the coil mass increases. This is shown in diagram 4, Fig. 3. Square wire or rectangular strip is better than round wire because of the larger contact area between adjacent layers. Enamelled wire is better than cotton covered wire because the insulating layer on each turn is thinner. The determination of the value of k for different sizes of round and square wire and for different methods of impregnating is a piece of work that remains to be done, a few values are given by Miles Walker.[1]

The effect of external wrappings on field coils is shown in diagrams 2 and 3, Fig. 3. Such wrappings cause the internal temperature to increase although under certain circumstances they may cause a reduction in the temperature of the external surface by causing a larger portion of the heat generated to travel inwards to the magnet core and therefore leave a smaller portion to be dissipated from the external surface.

PERMISSIBLE WATTS PER SQ. CM. ON STATIONARY FIELD COILS

Authority (date)	30° C. Rise (Thermometer)	50° C. Rise (Resistance)	Surface Used.	
Esson (1891)	0.085		Exposed.	
Kapp (1902)	0.116		Exposed.	
Wiener (1902)		0.106	Exposed surface and flanges.	
Thompson (1904)		0.104	Exposed surface neglecting flanges.	
Oërlikon (1904)		0.07	" " " "	
Goldschmidt (1905)		0.032	Total surface (external & internal).	
Hobart (1906)	0.104		Cylindrical surface.	
Neu. Levine & Havill (1901)		0.07	Cylindrical surface.	
Arnold (1906)		.067 to 0.10	Cylindrical surface and lower flange.	
Lister (1906)		0.05	Small 2 pole	Total external and internal surface.
		0.04	Open type (50 kw).	"
		0.033	" " (500 kw).	"
		0.025	Moderate size; protected	"
		0.02	" " ; semi enclosed	"
		0.017	" " ; " " ; interpole	"
Cramp (1910)		0.05 to 0.059	Metal former; no covering	External surface with flanges, also
		0.039	2 external layers of tape	1/3 (internal surface) with tight coils
		0.043	Impregnated & taped	3/4 (external surface, with ventilated
		0.036	1/8" covering of canvas	coils
Gray (1913)	0.05 + 0.0015 V (coil 8" long) 0.095 + 0.0025 V (coil 3" long) V = metres per sec surface velocity of armature.		External surface without flanges.	

FIG. 5. DATA ON FIELD COIL HEATING.

Some further data of interest on this subject is given in Fig. 4 which is a summary of a large number of tests made by Rayner.[2]

In actual machines a considerable portion of the heat generated in the field coils passes to the pole cores and is dissipated from the pole faces and from the yoke of the machine. The cooling effect of the poles decreases with increase of excitation, because of pole face losses, and with increase of load on the armature.

Some tests were made recently on a 6.5 h.p. motor placed in a tank which could be exhausted of air and the field coil heating was determined under the following conditions:

a. Armature running in air
b. Armature stationary in air
c. Armature running in vacuum
d. Armature stationary in vacuum.

The temperature rise was the same in the two latter cases.

An analysis of the results showed that for the particular machine 50 per cent of the heat was dissipated by radiation and conduction; 25 per cent by free convection and 25 per cent by forced convection produced by the fanning effect of the armature.

Empirical Formulae for Field Coil Temperature. Since the temperature rise of field coils depends on so many factors it is not surprising that many methods have been suggested by different authorities for its predetermination.

The formula generally used is

$$\text{Watts dissipated} = k_e \times t \times A$$

where A is the coil surface in sq. cm.
t is the temperature rise of the surface in deg. C.
k_e is the watts dissipated per sq. cm. per 1 deg. C. rise.

The permissible value of k_e depends on the interpretation of the terms coil surface and temperature rise. Some writers consider only the external surface of the coils neglecting the flanges, others include the flanges

[1] Specification and Design of Dynamo-Electric Machinery; Longmans & Co., 1915.
[2] *Eletrician*, Vol. 72, p. 702. Jan. 30, 1914.
[3] *Journal of Inst. of Elect. Eng.* Vol. 34, p. 613, 1905.

while some writers add the whole or part of the surface next to the pole core. Furthermore the temperature rise may be either the maximum rise, the average rise or that of the external surface.

Various values are given in Fig. 5. Each author must use judgment in applying his own constant because of the many different types of ventilation. The values given by the writer apply to standard open machines with radial ducts and without interpoles they must be used with a correction factor obtained from data such as that given in the table when interpoles are added and the armature ventilation is accomplished by other means.

HEATING OF ARMATURES

Timmerman's Tests. As far back as 1893 Timmerman made a very complete study of armature heating in the laboratories of Cornell. In order to have a definite surface with which to work he replaced the armature of a small two-pole machine by a brass cylinder inside of which a heating coil was placed. The temperature of the cylindrical surface was measured by thermometer.

The more important of his test results are shown in Fig. 6 which shows the effect of the speed of the armature, and in Fig. 7 which shows the effect of pole enclosure. The results were summed up as follows:

"An increase in the temperature of the armature causes an increase in the heat dissipation per degree rise so that an increase in the amount of heat generated in the armature increases the temperature of the armature but less than proportionately.

"The effect of the poles is to decrease the heat dissipation or the greater the pole enclosure the larger the temperature rise for a given loss."

The effect of ventilation in increasing the heat dissipating power of an armature is very marked, regarding this point Timmerman says: "Large machines will probably dissipate more heat per unit of barrel surface than does the experimental armature because for each sq. cm. of barrel surface of such machines there is more than one sq. cm. of dissipating surface, also the interstices between the wires cause greater convection and thus give additional means for the escape of heat.

That this latter prediction has been confirmed may be seen from the test curves in Fig. 8 for the heating of armature end connections.

Hinlein's Tests.* Designers have been fairly well satisfied with Timmerman's tests because his figures gave, for the heat dissipating power of a rotating armature, a minimum value that agrees with practice. Some recent tests by Hinlein, however, show that the subject is by no means exhausted.

Hinlein's apparatus consisted of a rotating copper cylinder with an internal heating coil. His work, however, differed from that of Timmerman in that provision was made to separate out the heat dissipated from the cylindrical surface from that dissipated by the cylinder ends and that conducted along the shaft.

A comparison of the two sets of results, as shown in Fig. 9 would indicate that the cylindrical surface does not dissipate heat as effectively as do the ends and this is quite possible. The flow of air over a rotating cylinder is as shown in Fig. 10 according to some tests that the writer made along with Prof. L. V. King of the Department of Physics at McGill University. There would appear to be something of the nature of an air film at the cylindrical surface through which film the heat has to be conducted. The velocity gradient around a rotating cylinder is shown at B, Fig. 10; at the surface of the cylinder the air has the same rotational velocity as that of the surface itself.

*Zeit. des Vereins Deutscher Ingenieure. Vol. 55, p. 730, 1911.

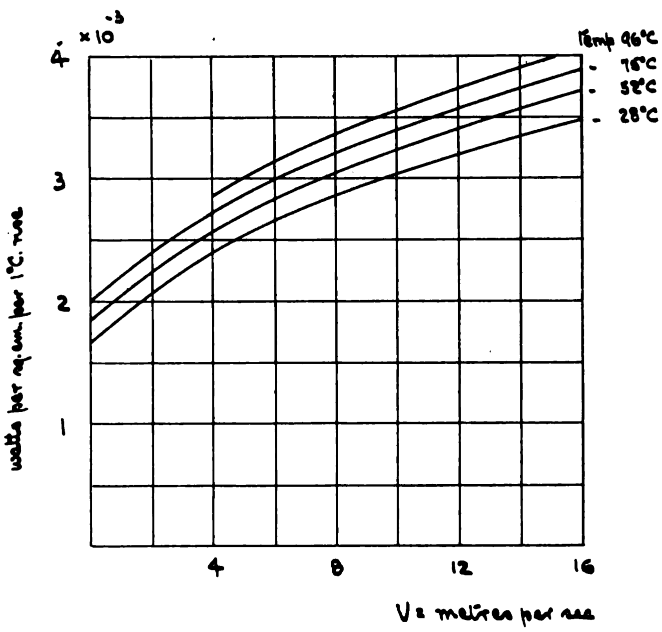


FIG. 6. EFFECT OF SPEED ON TEMPERATURE OF ARMATURE SURFACE.

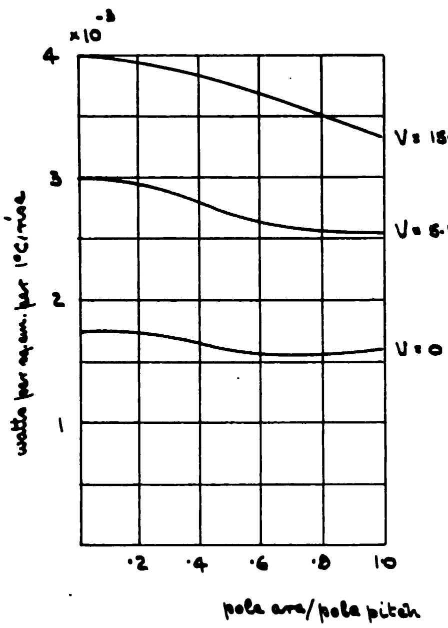


FIG. 7. EFFECT OF POLE ENCLOSURE ON TEMPERATURE OF ARMATURE SURFACE.

Ott's Experiments.[1] Ott measured the heat dissipation from a block of stationary laminations when air was blown across the surface with a measured velocity. Hinlein found that such a varnish layer improved the surface.

Czeija's Experiments.[2] In 1912 Czeija published

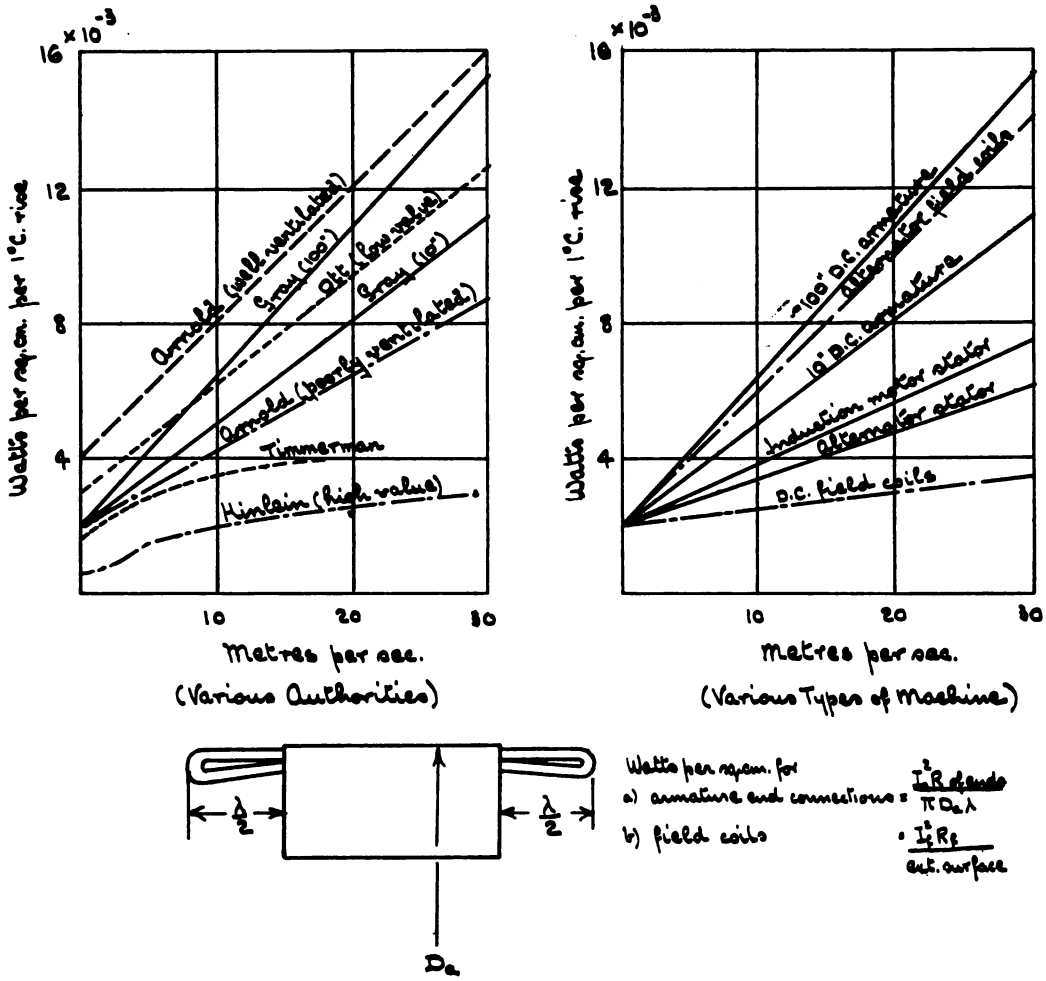


FIG. 8. TEMPERATURE RISE OF ARMATURES.

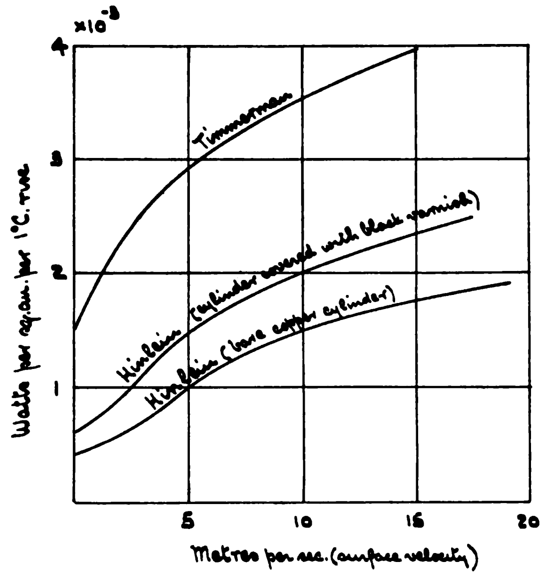


FIG. 9. HINLEIN'S TEST RESULTS.

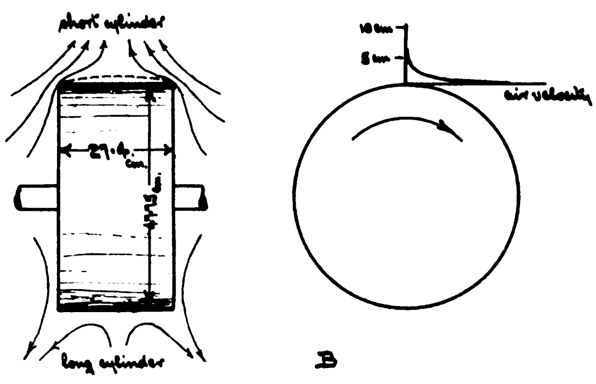


FIG. 10. AIR CURRENTS AROUND A ROTATING CYLINDER.

His test results, plotted in Fig. 11, differ from those of Hinlein in that he finds that a thick coat of varnish reduced the heat dissipating power of the surface while some data on the heat dissipating power of ducts in an iron core. In the one case the ducts were slits parallel to the laminations while in the other case

[1] *Electrician.* Mar. 7, 1907.

[2] Elektro. Zeit. Vol. 32, p. 313, 1912.

they were holes bored at right angles to the laminations.

The results, as shown in Fig. 11, agree approximately with those of Ott whose work was done on a laminated surface, but his test data on ducts parallel to the laminations is alarming to say the least and leaves the whole subject in such an unsatisfactory state that all the work ought to be repeated. The strange things about these different results is that no one of the writers criticises the work of the others.

Use of Vent Ducts. The iron core of an electrical machine has to be built up of laminations, about 75 to the inch. These are separated from one another by layers of varnish so that the conductivity of such a

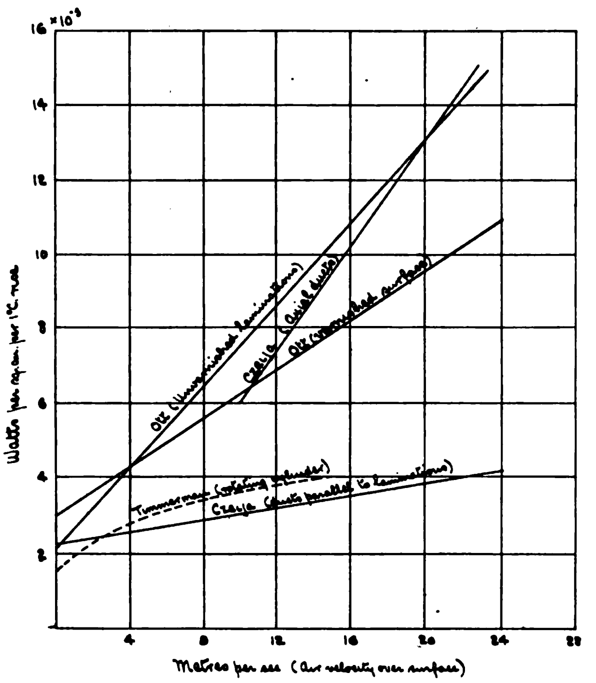


FIG. 11. COMPARISON OF TEST RESULTS BY OTT, CZEIJA, AND TIMMERMAN.

core is about 50 times as great along the laminations as it is across the laminations and layers of varnish.

Starting with the above fact as premesis many writers have stated that vent ducts such as shown in armature A, Fig. 1, are of little value because they run in the direction of the laminations. That such radial ducts are useful the writer has confirmed time and again particularly in the case of 25 cycle induction motors which have a fairly deep core. Several times a hot motor has had its temperature reduced by taking out half an inch of iron from the core and replacing it by a half-inch vent duct even although the core density and the iron loss were thereby increased. The point missed by many writers is that although the thermal conductivity of an iron core across the laminations is relatively poor, that across the air film at the boundary is poorer still.

One well known writer takes the vent duct surface into account by assuming that the velocity of the air through the ducts is one-twelfth of the peripheral velocity of the armature. The writer's own experience is that vent ducts help up to the point where the ducts are about 2.5 inches apart; a further increase in the number of vent ducts, although it adds heat dissipating surface, does not reduce the temperature for a given loss to any appreciable extent. As the subject now stands we have no data available from which to ascertain whether the ducts are effective because they add to the armature surface, because they supply air to the external surface of the armature and break up the air films that tend to form there, or because the air feeding the ducts has to pass across the inside surface of the armature core.

Tests on Actual Machines. When one comes to analyze the heat tests obtained from actual machines and compares them with experimental results such as those already quoted, the difficulty of the subject becomes apparent. Test data on modern direct current machines is given in Fig. 12 and the results are remarkable to say the least.

The commutator has open necks so that the air circulation is very effective and much of the heat is conducted to and dissipated from the necks themselves. A comparison between the values for a commutator and those obtained by Timmerman for rotating cylinders shows how effective the open necks must be but no one so far has had the courage to suggest a more rational method of figuring the temperature rise of a commutator than by using the barrel surface.

The armature surface again, as shown in Fig. 12 is apparently a much better dissipator of heat than are the end connections but this is largely due to the fact that what is called the core loss is not all located in the armature, in fact much of the so-called core loss is located in the pole faces and in the armature spider and end heads and these losses do not heat up the armature surface. A simple rule that the writer has found from practice is that the temperature rise is proportional to the copper loss $+0.3$ times the core loss. In this connection the following test data obtained from a 700 kva., 2200 volt alternator is of interest.

When the alternator was tested on open circuit and the core loss was 23 kw. the temperature rise of the stator was 29°C. When the same alternator was tested on short circuit and the short circuit loss was only 12 kw., the temperature rise of the stator surface was 36°C.

EFFECT OF SPEED ON VENTILATION

A discussion of this subject is best taken up along with a discussion of the development of high speed alternators.

One is at first inclined to think that the slow speed machine is the most difficult to cool but such is not the case. In the slow speed machine the output per pound of material is limited by the necessity of keeping the losses down so as to meet the efficiency guarantees and is not limited by heating.

The temperature rise is approximately proportional to (watts loss) / D L

and D^2L = a constant $\times$ watts / rpm. is the well known output equation.

From these two formulæ we find:

temp. rise = k (watts loss / watts) D rpm.

= a constant × per cent loss × perip. vel.

In slow speed machines the change of air over the heated surface is brought about by a pressure difference

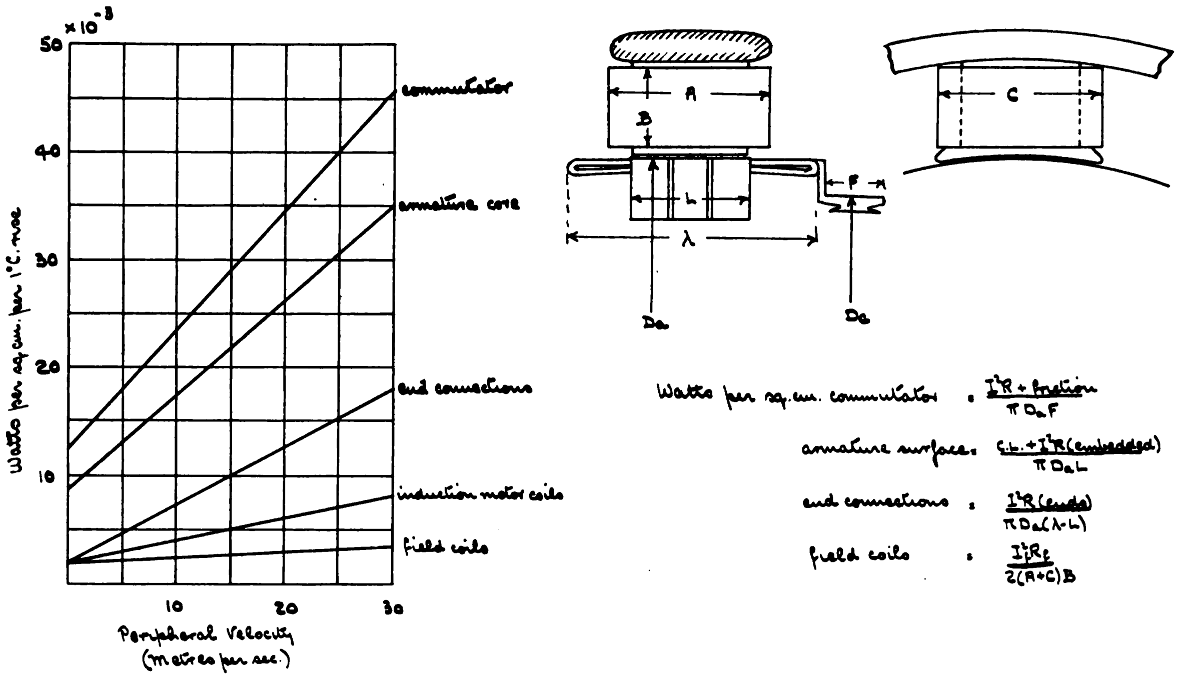


FIG. 12. TEMPERATURE RISE OF VARIOUS PARTS OF D. C. MACHINES.

created by the rotation of the rotor itself. The air currents then flow as shown in A, Fig. 13 This air is not always directed where desired, and the streams are rather unstable so that sometimes one side of the machine is cooled better than the other. With machines of this type the draft caused by the opening of a door is sometimes sufficient to change the direction of the air currents passing through the stator and completely change the temperature distribution in the core and windings. This is often prevented by fans, which are added to the rotor for the purpose of making the air streams stable rather than to increase the ventilation.

For moderate speed machines the improved ventilation required to keep the machine cool is obtained by the addition of fans to the rotor and the housings are frequently made solid, as shown in diagram B, Fig. 13 so that the air is deflected over the back of the stator core.

For high-speed water-wheel driven units the frame is generally long as shown in diagram C, Fig. 13, in order to keep down the peripheral velocity. In such machines it is necessary to create an air pressure in the end bells in order to force the air between the poles and out through the vent ducts in the center of the stator core; this is accomplished as shown and the openings at D can be supplied with baffles so that the distribution of air may be adjusted while the machine is being tested.

Still higher speeds are found in turbo alternators and forced ventilation becomes necessary, but this opens up too wide a field and is not discussed here.

Conclusion. The whole subject of temperature rise of electrical machinery is too extensive to be considered in great detail. The writer has discussed the fundamental principles of heat dissipation from stationary surfaces, from surfaces over which air is blown and from rotating cylinders and has shown how the results of laboratory test compare with results found on actual machines. It is obvious that there is much work still to be done of a nature that can be better done in the laboratories of a technical school than in those of the manufacturer. The subject of transformer tanks has not been considered nor has that of totally enclosed machines the former of these two subjects will yield fruitful results if handled with intelligence and patience.

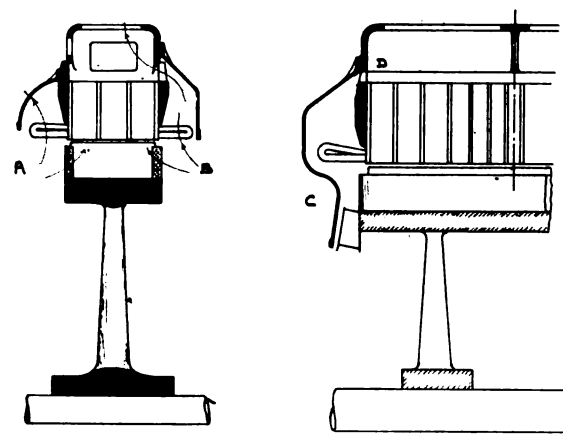


FIG. 13. ALTERNATOR VENTILATION.

In conclusion one must confess that the designer who spends much of his time on the test floor with his machines will have greater success in designing cool machines than he who sits at his desk and applies formulæ. The study of the air currents and the effect of baffles, of housings, and the other parts of the machine in directing the air currents to the hot spots is one of great fascination.

A NOVEL TWO-STROKE ENGINE

By J. A. FISH, '12 *

A novel and interesting addition has recently been made to the field of internal combustion engines in the form of a very light weight, two-stroke engine capable of speeds up to 4,500 R. P. M. This engine has a two inch bore, one and three-quarter inch stroke and develops one H. P. at approximately 2,250 R. P. M. It runs smoothly even at its greatest speeds. Two-stroke engines capable of such speeds are decidedly

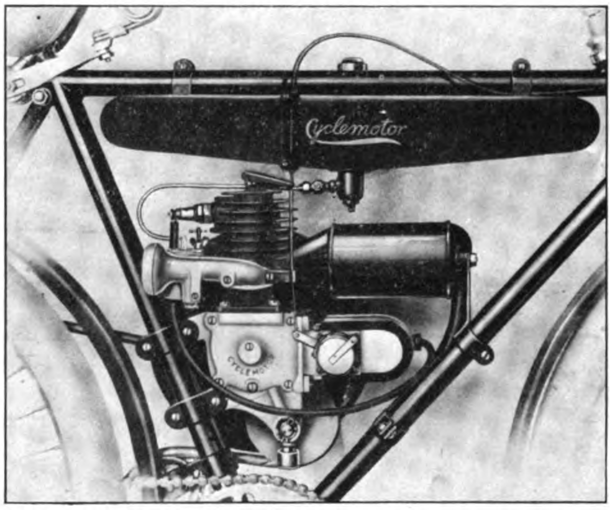


Fig. 1—Cut of Motor in frame.

uncommon, therefor, some of its details and problems in its design are likely to be of interest to the Engineering profession.

Reliable experimental data concerning small two-stroke engines is very meager so that the original determination of port sizes and port timing had of necessity to be made from data of average practice which was gathered from successful engines used in English light-weight motor-cycles. The original layout proved nearly correct and needed only slight revision. Revised port data is given in the following table:

Port	Length of Chord	Width	Projected Area	Percent of Piston Area	Width in Percent of Stroke
Intake	1"	$\frac{5}{16}$	0.3125	9.95	17.85
Transfer	1"	$\frac{5}{16}$	0.3125	9.95	17.85
Exhaust	1"	$\frac{7}{16}$	0.4375	13.9	25.0

Fig. 2

The valve diagram in Fig. 3 shows the location of the ports along the cylinder bore, the position of the piston relative to the ports at various points in the stroke, and the port timing obtained from this arrangement.

As stated above, this port arrangement is based entirely upon empirical data and is not necessarily the correct arrangement for highest operating efficiency. This point can be determined only by the results of experimental work now in progress. Even though it does give very good results in this particular motor, the arrangement cannot be unreservedly recommended as being suitable for any motor having even approximately the same dimensions.

In this connection, Fig. 4, is given showing the duration of opening of the various ports and the actual area of opening at different points between the opening and closing of the ports.

It will be noticed that the transfer port stays open longer and has a larger average area of opening even though the two ports are exactly the same size. Assuming the intake port dimensions to be correct, the transfer port is apparently too large as it is required to pass the same weight of gas as the intake port but this gas has been compressed in the crank case, hence is smaller in volume than when drawn through the intake port.

However, it must be remembered when designing an engine of this type that the gas must have a free passage into the cylinder or, at the higher speeds, the charge will never get as far as the combustion chamber. So in the absence of refuting experimental data, the arrangement is amply justified by the fact that "It works."

Some of the mechanical features embodied in this small engine are unique and therefore interesting.

Perhaps the most radical departure from current practice is the position of the muffler directly on the cylinder casting. This position is particularly efficient on a small motor as it allows the burned gases to expand from the exhaust port directly into the large

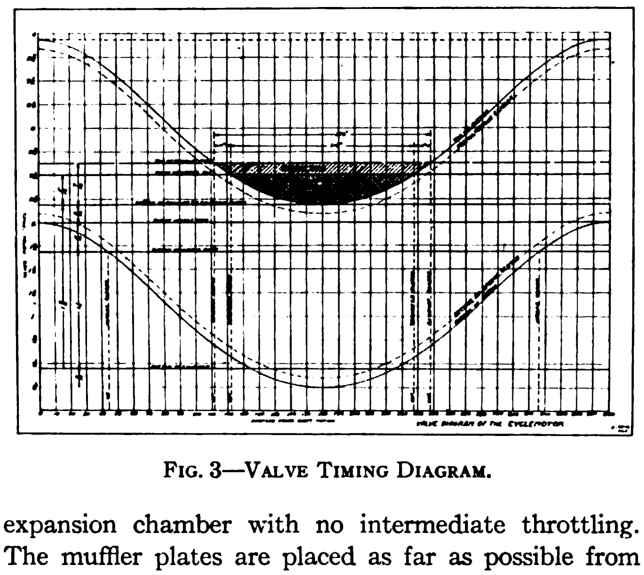


Fig. 3—Valve Timing Diagram.

expansion chamber with no intermediate throttling. The muffler plates are placed as far as possible from the exhaust port to obtain the full benefit from this expansion with its resultant cooling. With this arrangement the gas is materially cooled immediately upon issuing from the port and obviates two common two-stroke troubles viz: burning away of the port edges and excessive carbon deposits in the exhaust port.

*Service Manager, Cyclemotor Corporation, Rochester, N. Y.

The function of the baffle-plates is to break up the sound waves rather than to throttle the gas. Accordingly thay have a decided clearance inside of the muffler shell. By measurement with a Diehl Electric Dynamometer very little difference in power can be detected with and without the muffler. This muffler

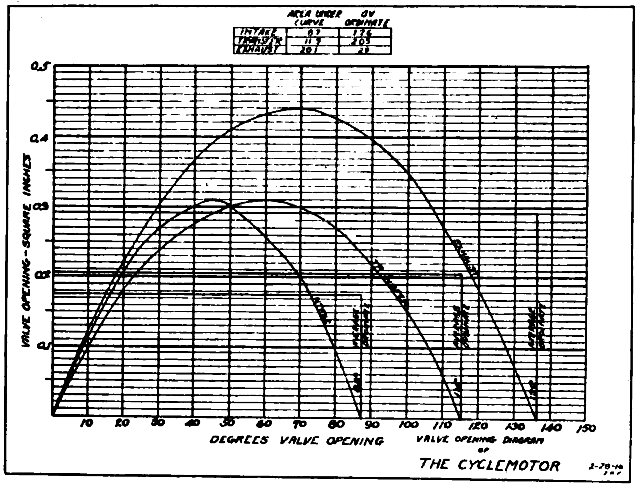


FIG. 4—VALVE OPENING DIAGRAM.

together with its long tail pipe effectively muffles the explosions and produces a very quiet motor.

The three-point chain drive, furnishing a two to one reduction to the drive pulley is another unique feature. The chain used is a very high grade English roller chain one-half inch pitch and one-eighth inch wide. Its success in this particular instance where the linear velocity runs as high as 1800 feet per minute has been a revelation even to the chain manufacturers. The principle requirements for success are that the sprockets be correctly cut, that they be in accurate alignment and that the chain have the proper tension. With present day machine tools and shop methods the first two requirements are easily obtained. Chain tension is adjusted by shims between the magneto and the crank case.

Looking at the engine from the carburetor side, as shown in the cut, its direction of rotation is clockwise. The magneto is so placed that it is driven by the loose side of the chain and its bearings are subjected only to such pressures as are occasioned by its own drive.

The large diameter fly-wheel is made from a sheet metal stamping and acts also as a guard for the chain drive. It is very light but its large diameter together with its high speed of rotation provides plenty of fly-wheel effect. A wheel one inch larger in diameter was found to be too large as it made the motor sluggish and prevented rapid "Pick-up."

The carburetor for a high speed two-stroke engine must of necessity be very simple.

Automatic air valves are useless because of the difficulty in making them light enough to follow the rapid variations in the suction pressures. Valve springs for a small motor must be very weak and even the small inertia possessed by valves made from the very lightest materials is sufficient to prevent their rapid movement and they will stay in any position where they happen to come to rest as the engine starts.

The carburetor used is the simplest float feed type. The nozzle is the only peculiar feature. Being of large diameter and projecting into the intake pipe, it furnishes a constriction which acts something like a Venturi Tube. Seven small holes are drilled in the end of the nozzle to furnish ample area for passing the fuel mixture of gasoline and lubricating oil and to break up the fuel into a fine spray. The large number of holes also minimizes the danger of trouble resulting from a plugged nozzle.

The enlarged end of the air intake provides room for a baffle plate to catch the "blow-back" through the intake port as the piston descends and before the port is covered. The "blow-back" carries with it a certain amount of lubricating oil which is objectionable if allowed to accumulate. In addition to catching the oil, the baffle plate has a silencing effect which materially reduces the noise of the inrushing air.

The National magneto is designed having in mind the light weight and high speed requirements. It runs at crank shaft speed and furnishes a spark at each revolution of the armature. To construct a breaker for continuous high speed operation it was found necessary to use a very gradual breaker cam in order to prevent rapid wear at the bearings in the breaker arm. The breaker is so designed that centrifugal force tends to hold the points together and produce a perfect contact.

The commercial production of this type of motor requires the most careful attention to every detail. If the motor is to deliver its power, it must have proper compression in both the cylinder and the crank case and the moving parts must be perfectly free in all positions when the motor is hot. To attain these

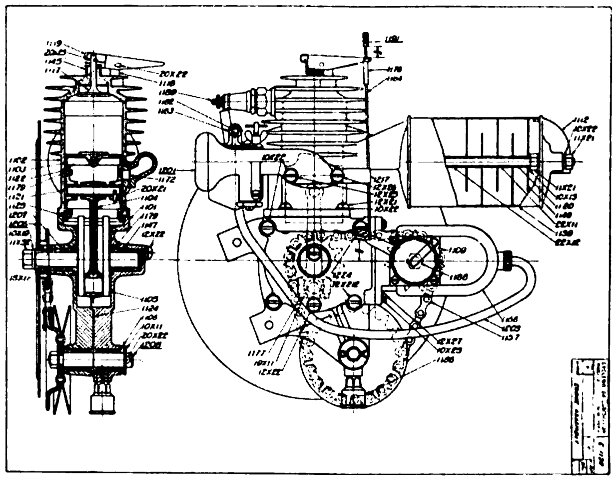


FIG. 5—SECTION OF ENGINE.

ends and to insure a continuous satisfactory operation, all clearances must be carefully determined and the parts accurately machined to close limits in order to maintain these clearances.

It has been demonstrated that the closer the fit between the piston and cylinder, the more power will

be obtained. But with an original close fit great precautions are necessary to prevent either of these parts from warping when heated and vibrated under operating conditions. These precautions start in molding of the castings. The cylinder casting is machine molded and, after the cores are set, the mold

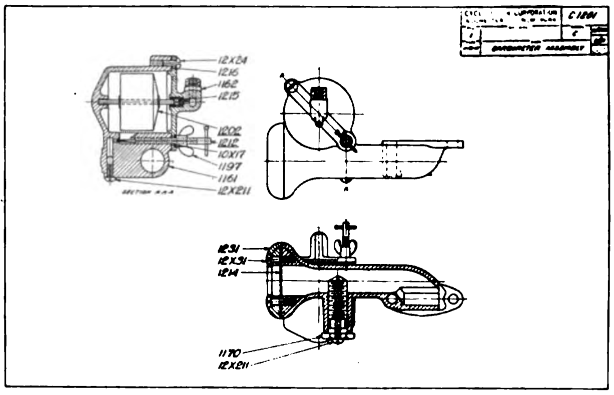


FIG. 6—CROSS SECTION OF CARBURETOR

is baked before pouring. This dries the mold and so prevents chilling the thin sections of the casting with the consequent internal stresses.

The cylinder and piston castings are rough machined and are then allowed to age for a period of two months. At the end of that time they are finished approximate to size and then thoroughly annealed by heating to a red heat and slowly cooled before the final grinding operations.

The maximum allowable difference in diameter of the cylinder and piston is .003″ while the minimum is .001″. Of course the piston is appreciably cooled by the fresh gas in the crank case and probably the clearance is somewhat greater under operating conditions due to the greater expansion of the cylinder. However, if the castings are properly treated, no trouble from warping is experienced and even with the minimum clearance, a motor has never been known to sieze.

The lubrication problem has not been difficult probably on account of the low piston speed and light bearing pressures. The outfit on the road has a maximum speed of about 20 miles per hour with a corresponding engine speed of 3,000 R. P. M. This produces a piston speed of 875 feet per minute which is very low for this type of engine. Sufficient lubrication is furnished by oil mixed with the gasoline in the proportion of one part oil to sixteen parts gasoline. The oil must be very carefully chosen. In the first place it must be a heavy body gas engine cylinder oil but a large number of oils which give perfect results in a splash or forced feed lubricating system apparently lose their lubricating qualities when mixed with gasoline. No set of physical properties can be specified which will guarantee a satisfactory oil for this purpose so the selection must be the result of experience.

Each motor is given a very strenuous test before shipment. In the testing department they are belt driven at 1,200 R. P. M. for nine hours during which time oil is fed into the crank case through the intake port. After this running in they are direct connected to a Diehl Electric Dynamometer and run under full load for 45 minutes at 1,800 R. P. M. This is equivalent to 12 miles at 16 miles per hour. During this run the motor is given extra oil through the carburetor air intake and is cooled by a blast of air from directly overhead. After five minutes cooling, the motor is required to show a certain torque at pre-determined speeds with actual operating lubrication before it is passed for shipment.

The curves in fig. 7 show average results from ten motors coming off test in the regular manner.

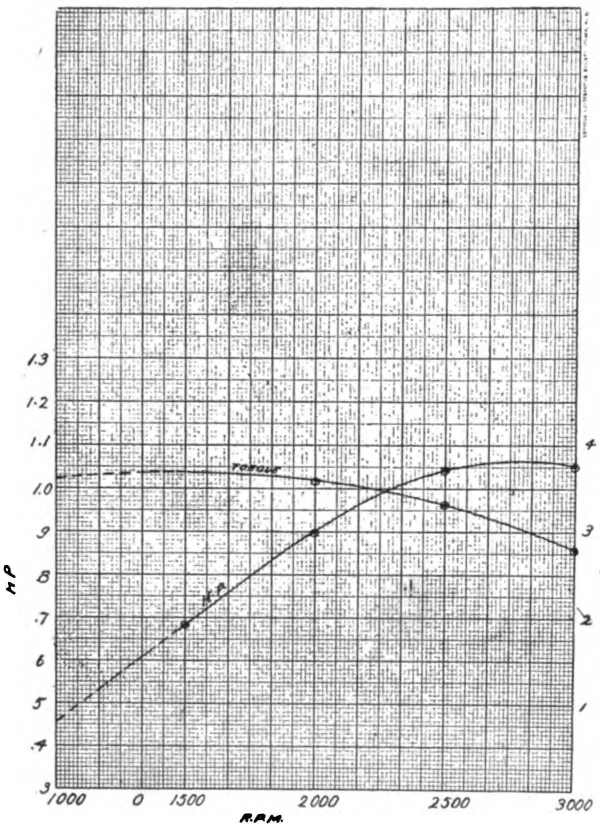


FIG. 7—HORSE POWER CURVES

The power of the motor increases very materially with extra running and the consequent smoothing of the parts. Ground cylinders and pistons give considerable more power than turned or reamed parts thus proving the necessity for careful and accurate workmanship.

UNIVERSITY NOTES

CHANGES IN THE SIBLEY FACULTY

Prof. C. F. Hirshfeld, who has been on leave of absence, has resigned to continue as of Head of the Research Department of the Detroit Edison Co., which position he has held for some time.

Prof. R. L. Daugherty, has accepted a Professorship in Hydraulics in Rensselaer Polytechnic Inst., Troy, N. Y.

C. B. Bennett, E.E. Department, is with the Wagner Electric Co., St. Louis, Mo.

C. D. Corwin, Instructor in Machine Design, has resigned to work with the Corona Typewriter Co., Groton, N. Y.

G. C. Mills, also Instructor in Machine Design, has accepted an Instructorship in the Carnegie Institute of Technology, Pittsburgh, Pa.

W. G. Catlin, Instructor in Electrical Engineering, is a Design Engineer with the Shephard Electric Crane Co., Montour Falls.

C. G. Brown, Instructor in Electrical Engineering, is with the Rochester Ry. & Light Co., Rochester, N. Y., in charge of the Research Laboratory.

H. H. Waters, Instructor in Machine Design, is Testing Engineer with the Thomas Aeromotor Co., Ithaca, N. Y.

R. W. Graham, E.E. Department, is Assistant Engineer with the Lackawanna Steel Co., Buffalo, N. Y.

W. A. Gibson, Experimental Eng'g Dept., is with the Aluminum Castings Co., Buffalo, N. Y.

E. H. Dix, jr., Experimental Engineering Department was engaged in Research Work for the Morse Chain Works, Ithaca, N. Y., during the summer months.

McR. Parker, Machine Design, is Engineer with the Bell Telephone Co., with headquarters at 1230 Arch St., Philadelphia, Pa.

H. M. Sharp, Electrical Engineering, is with the Lackawanna Steel Co., Buffalo, N. Y.

Prof. W. S. Ford, on leave of absence, is with the Vacuum Oil Co., at Paulsboro, N. J.

Prof. W. M. Sawdon will be absent during the first term on a sabbatical leave of absence.

F. G. Bænder, former Librarian of the Sibley College Library, is Professor of Mechanical Engineering at the University of Arkansas, Fayetteville, Ark. Mr. F. L. Fairbanks, '10, of Pendelton, Oregon, will be the new Librarian.

Besides the above losses and promotions the Department of Machine Design has lost Prof. H. D. Hess, Instructors T. O. Hussey, A. J. J. van der Does de Bye, C. G. Thatcher, H. Stephenson, and Assistants H. N. Diedrichs, and C. H. Landon; the Mechanics Department has lost D. R. Francis; Power Engineering, E. T. Jones; Experimental Engineering, J. L. Landt; and Electrical Engineering, H. M. Sharp.

The following promotions have taken place: from Assistant Professor to Professor, C. D. Albert, Machine Design; A. E. Wells, Machine Construction; F. O. Ellenwood, Power Engineering; from Instructor to Assistant Professor, M. A. Lee, Machine Design; J. G. Pertsch, Electrical Engineering; C. A. Peirce, Power Engineering, and C. H. Berry, Power Engineering.

The following additions to the faculty have been announced: William Emerson Mordoff, Elbert Aldrich Taylor, Robert Gephard Meyler, Hugo N. Diederichs, William Carl Andræ, Fred W. Armbruster, Paul Fenton, Instructors in Machine Design; Carlos Elmer Harrington, George Austin Worn, Assistants in Machine-Design; William Joseph Gavett, Carlos Child Knox, Instructors in Experimental Engineering; Frederick George Switzer, Instructor in Hydraulics; Homer James Hotchkiss, Harold Charles Perkins, Instructors in Mechanics of Engineering; Joseph Franklin Putnam, Assistant Professor in Electrical Engineering; George Francis Bason, Alejandro R. Cota, Ralph Berry Stewart, Martin Collins Hughes, Instructors in Electrical Engineering.

Asst. Prof. Ham has been duly elected to membership in the A. S. M. E.

Prof. Dexter S. Kimball has gotten out a new edition which is enlarged fifty per cent. of "Cost Finding," published by the Alexander Hamilton Inst.

PHYSICS DEPARTMENT NOTES

Due to illness Prof. Ernest Blaker will be unable to start his work at the beginning of the term. Until he returns Mr. C. C. Murdock will have charge of his classes.

Mr. C. L. Swischer has been appointed Professor of Physics & Electrical Engineering at the State School of Mines, Rapid City, S. D.

Dr. R. W. King has resigned his instructorship in Physics but will remain at the University to devote his entire time to Research, working under a Carnegie Grant.

Dr. E. H. Kennard formerly an instructor in the University but for the past two years at the University of Minnesota, has been reappointed instructor in Physics.

INDUSTRIAL REVIEW

The Spray Engineering Company, 93 Federal Street, Boston, Mass., have published three new bulletins, "Spraco System for Cooling Condensing Water," "Cooling Water for Ice Plants," and "The Vaughan Flow Meter." They will be of interest to engineers in refrigerating and steam plants.

Lidgerwood Cableways. A bulletin issued recently by the Lidgerwood Manufacturing Company of 96 Liberty St., N. Y., describes the uses to which cableways may be put. It describes with illustrations, large cableways at work on several of the large concrete construction jobs throughout the country. Special reference is made to the advantages and special features of the Lidgerwood Cableways showing their adaptability to large work. Copies of this valuable bulletin may be had by addressing the Lidgerwood Mfg. Co., at the above address.

Roebling Wire Rope. Vol. 1 No. 4 of John A. Roebling's Sons Co. contains several interesting and valuable articles on the use and care of wire rope appliances. The first short article is on wire rope practice as applied to electric cranes, the second on wire rope tackle used in construction work. These two articles together with others might be used to much advantage by the construction or job engineer on works where wire rope is used. The excellent illustrations exemplify the subject of the text. The titles of the other articles are: Roebling Wire Rope Slings; Aerial Wire Rope Conveyors; Derricks; Increased Efficiency in Mine Rope Service; Proper Care of Wire Rope in Operation.

PERSONALS

W. D. Mount, '90, General Manager of the Mathieson Alkali Works has been made a director of that company.

James Francis Barker, '93, resigned the office of principal of the East Technical High School in Cleveland, Ohio, to become head of the Mechanics Institute in Rochester, N. Y.

Emmett B. Carter, '99, Chief Engineer of the Midvale Steel Co., Nicetown, Philadelphia, Pa., is the president of the Engineers' Club of Philadelphia, an organization of 2500 members.

C. S. Adam, '04, is now with the Pierce-Arrow Motor Car Co., Buffalo, N. Y.

Roberto J. Shalders, '04, is the manager of the soap and candle factory of Castro & Oliviera in Rio de Janiero. His address is Caixa de Correio, No. 356 Rio de Janiero, Brazil.

Harvey B. Mann, '08, is the happy father of a daughter, Jane B., born July 26.

Barrett Smith, '04, had charge of the electrical division of the industrial exhibition "Fifty Years of Technology" held by the Massachusetts Institute of Technology, late in June, to commemorate its fiftieth anniversary and the moving into the new home in Cambridge. He was appointed by the Stone & Webster Engineering Corp., which had been asked to handle that branch of the exhibition. It covered the branches of water power, power transmission, central station practice, electric railways, electric lighting, motors and turbines. Smith organized the advertising department of Stone & Webster and had charge of it for several years, but it is now under the management of Lewis E. Palmer, '05. Smith is now engaged in the advertising business independently, with an office at 20 Central St., Boston, Mass.

John Adendorft, '07, of Kimberly, South Africa, has been appointed as Assistant Professor in Machine Design and shop superintendent in the College of Applied Science, Syracuse University.

Chas. W. Mortimer, '07, has been promoted to be Second Assistant Examiner in the U. S. Patent Office.

Emanuel Fritz, '08, is now located at the Fort Valley Experiment Station of the U. S. Forest Service at Flagstaff, Ariz.

Edward H. Clark, '09, was married to Miss Ruth Bessier, daughter of Mr. and Mrs. Eugene Bessier, of Ithaca, on Aug. 8. Mr. and Mrs. Clark will make their home in Cortland, N. Y., where Mr. Clark is the manager of his father's paper, the *Standard*. Mrs. Clark is a graduate of the Cortland Normal School.

Lieut. A. C. Sullivan, C. A. C., '09, was married October 12 to Miss Katherine Arnold of Muncie, Ind., the wedding taking place at Corregidor, Philippine Islands.

George Frederick Jewett, Jr., '10, of Montclair, N. J., announces the birth of a second daughter, Jean Tennent, born July 14.

Herbert B. Reynolds, '11, M.M.E., '15, has changed his residence to 30 W. 71st St., New York City. He is the assistant engineer of the motive power department of the Interborough Rapid Transit Co.

Lyman A. Talman, '12, was married to Miss Rose E. Hiller of Attica, N. Y., on June 22. Talman just graduated this year from the New Brunswick Theological Seminary and is going as a missionary of the Reformed Church at Amoy, China.

OBITUARY

R. H. Harrison, '10

Raymond H. Harrison, M.E., 1910, died on August 10 at his home in Orange, N. J. An acute form of anæmia was the cause of his death. He was twenty-six years old and was born in Orange, where he had lived all his life except the four years when he was at college. He was employed by the Public Service Corporation of New Jersey. His parents and two sisters survive him.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY *Copyright by The Sibley Journal of Engineering, Inc., 1916* ITHACA, N. Y.

Vol. XXXI NOVEMBER, 1916 No. 2

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President

WILLIAM N. BARNARD, Vice-President

EARL G. HENDERSON, Secretary-Treasurer

CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year

Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

CONTENTS FOR NOVEMBER, 1916

A Broader Viewpoint

The tendency of modern technical education is toward narrowness; the subjects for instance in the curriculum of Sibley College are exclusively related to engineering. We of the faculty feel that all subjects now given are of prime importance in the training of men who are to become engineers. Possibly in our nearness we may have lost something of our sense of perspective, and may have taken "desirableness" for "necessity"; it may be that the small coin before the eye hides the sun. It is certain that all subjects given are desirable, but is it certain that each one is more desirable than every other thing that might replace it?

More and more the trained engineer, for he is also a trained man, is called on to take part in non-professional affairs for the benefit of all; he is called only if he is prepared, and he is not prepared if his boundaries enclose only the technical field and then the highest success is not open to him. Moreover, success in modern engineering itself does not result solely from engineering ability and training. The most important inventions and engineering schemes require financial support, and must therefore be presented clearly and convincingly to financiers; if the engineer who presents them lacks, in culture and character, the things that seem desirable to the financier, his cause, no matter how good, is half lost before he begins. If the presentation is by means of written report, this report must be not only correct but concise, logical and cogent; it must show a cultivated brain and also a cultivated imagination. The engineer of the present and the future must be a man of broad culture if he is to rise to higher things in his profession and in human life.

For several years Professor Sampson, head of the Department of English, has given readings twice a week for the men of Sibley College. These readings, from five o'clock P. M. till the chimes rang, began just after Thanksgiving and continued until the Easter recess. Professor Sampson read poetry, plays, stories and essays and covered the wide range from light humor to tragedy. Many Sibley students have listened to these readings with great enjoyment and have received suggestion and impulse for the formation of a habit of reading that will help them to become broad-minded and cultivated men.

Recently it was suggested that those who attend these readings regularly in future should receive one hour elective credit toward the M. E. degree. This suggestion in informal discussion met with hearty and general approval and was adopted at the faculty meeting.

It is believed that one of the best ways to gain in ability to speak and to write good English as well as in capacity for effective living is to keep on reading daily

the best things that have been written, and to keep on writing daily out of a mind steadily growing stronger, with a taste steadily growing more discriminating. Thus the narrowing tendency of the technical courses can be overcome and power can be developed. It is fortunate for the students of Sibley College that Professor Sampson is willing unselfishly to take on this extra work in order to supply this initial stimulus that may produce this result.

Albert W. Smith.

Absorption and Radiation

There is a law of physics that a body which absorbs energy also gives out energy. The sulphides of the mineral earths after exposure to ultra-violet rays become phosphorescent, radiating energy. The moon and planets shine, reflecting radiant energy received from the sun. The earth on the "day side" absorbs energy of the sun's rays, and on the "night side" radiates most of this energy into space; but a part of the energy received by the earth is caught by nature and stored as mechanical energy in water at high levels, or as potential heat energy in the products of plant growth, such as coal, petroleum, or natural gas. Energy may be stored for long periods, but it is available for the use of man or for some other use in nature's economy, and eventually is given out. Through the agency of absorption and yielding up of energy the earth has been transformed from a barren cinder into a habitable and more or less pleasant place. Thus all good things—as well as many bad ones—result from interchanges of energy.

In the case of mental energy, however, it is possible to evade the law; one may receive without rendering a return, and many accept the opportunity. An energetic, radiating person having received knowledge and mental stimulus with experience, mixes them with his own brain-product and gives out new knowledge for the use of all. Thus he obeys the law. But many who receive his product put it in store and never mix it with thought nor render due return to the world.

There are many others who receive, transform and use the product of other brains, but who think they are too busy to put the product of their own brains at the service of others; they have no time to obey the law.

Probably every man who reads THE SIBLEY JOURNAL has developed out of study, experience and careful thought, something that would help other engineers if he would put it into printed words; why should he confine its usefulness to one case or group? Why not formulate it and send it to the JOURNAL or to some other technical society or magazine?

The chief difficulty met by the engineer in entering new fields is lack of trustworthy records of careful experimentation; he must repeatedly turn aside in his progress toward the desired result to check or determine required data which doubtless, in most cases, have been determined by others, but never recorded for the use of all.

The data of engineering will approach completion much more rapidly when all engineers take pains to record all items out of their experience and thought that can possibly help their fellow engineers.

The idea, that they are thus giving out that which has cost them much without return, is fallacious; as is every selfish plea; for it is eternally true that he who gives shall receive; even as Professor Sweet, who gave always so freely from so rich a store, received so bountifully of the best things that can come to one in this life.

Sibley Athletics

In any large institution of learning we find all sorts of men and of widely varying interests and degrees of activity as regards not only their studies but their "outside activities." Those possessed of a little more energy than others enter into contests of a journalistic, administrative, athletic or some other nature quite separate from their studies. In one way and another participation in these various activities undoubtedly leads them to have a stronger and sounder affection for their Alma Mater. For example, consider a man whose ambition has been to "get by" with marks of 60 or 70. He has never been aroused by the call to come and help carry some burden and has never shared the joys and sorrows of real competition. In contrast consider the man who, feeling that he was really a PART of the community, was willing to get under the load and with good courage keep up his end. They say "tis more blessed to give than to receive" and that this is one reason for the deep affection of the mother toward the child. I have often heard men who were in Sibley College in the days gone by tell of the spirit of Sibley and how the engineers were the spirit of Cornell. Look around the Sibley library and SEE the cups, the banners, and various other trophies won by Sibley College in contests with the other colleges. "Seeing is believing." The old question was "Who will get second?", granting Sibley first. Now it seems to be "When will Sibley come in?"

The old topic for argument is ever rampant between the engineer and the other colleges as to the work and spirit of each. Are you going to stand by now and say "Yes, you were right." Are you going to lift or are you going to lean?

We have about as many MEN in Sibley as there are in Agriculture and yet where did you let the trophies go last year? What happened in basketball, in cross-country, in EVERYTHING? It is true that we have a good percentage of men in the major sports and that leads to the point of why so many cry down the major sports and athletics in general. They proclaim "It is for the few, for those who least need the exercise." Here is the chance to get out of this rut of intensive athletics and play your games on the extensive plan. More men into more activities!

Do not overlook this point. Men who make good in intercollege athletic sports come before the eyes of the major sports coaches and many times good track

(*Continued on page 48*)

A STUDY OF HEAT TRANSMISSION IN STEAM BOILERS

By VICTOR R. GAGE*

PREFACE

The experimental work was done by Mr. V. R. Gage working at first with Mr. A. G. Kessler, and later with Mr. T. B. Hyde. The data was worked up by Messrs. Gage and Hyde. From time to time new interpretations and ideas have been applied to the original thesis, and are included herein.

Recent investigations in baffling water tube boilers are an attempt to eliminate the pockets of dead gas shown in the experiments on the first (water tube type of) boiler.

In the research recently made public by the Babcock & Wilcox Company the direct measurement of temperature of the gases is avoided. In this connection the Kinetic theory and turbulent flow mentioned later may prove interesting.

The traverses showing the relation of temperature and velocity of the gas across a diameter of a boiler tube are entirely new, as far as our knowledge goes, altho since these were made others have taken temperature traverses.

WATER TUBE BOILER

Apparatus

The first boiler used was a model of a section of a B. & W. water tube boiler. It had two vertical rows of 1½" tubes, four tubes in each row, and the tubes were staggered. These were enclosed in an asbestos lined sheet iron case. The firebox was external, eliminating direct radiation to the heating surface. The steam drum was also external, but was well insulated, as was other exposed piping. City gas was burned as fuel, air was supplied by a blower, both were metered. The flames impinged upon a checkerwork fire-brick baffle, which also prevented luminous radiation to the tubes. The radiation from the burning fuel is a large source of heat ordinarily, the laws are comparatively well determined, but this radiant energy is not wanted in experimental work of this character. Steam was generated at nearly atmospheric pressure, condensed, and weighed. As the boiler can not be divided into sections on the water side, this served only as a check on the over all heat loss of the gases. The feed water was heated. Base metal thermo-couples, not shielded, were placed three at the entrance and three at the exit of the first and second passes. Mercury thermometers were placed, two at the entrance and two at the exit of the third pass, and one in the center of the flue. All the temperature measuring stations are shown on Figure 1, a vertical section through the boiler.

Conditions Affecting Results

There were many difficulties, encountered with this apparatus, which have a direct bearing upon the results.

All of the heat given up by the gases was not absorbed by the water. Various means were devised for insulating the setting or sheet iron case, but none were satisfactory. Conditions of thermal equilibrium were never established, although the boiler was always operated for a considerable time before data was taken.

The velocity of the gas was an inconvenient variable, as the area was reduced in each succeeding pass, and with it, of course, the heating surface.

The wide variation of temperature, at different points in a plane at right angles to the baffles, indicates some stream lines of hot gases at high velocity, other lines of low temperature slowly moving gas, and pockets of dead gas. A little work was done on baffling at the entrance to the first pass, but with no success at distributing the temperatures. The hot line could be shifted. It also shifted of its own accord with variation of quantity of gases. If a study of this phase should be made, Pitot tubes must be employed in connection with pyrometers, and the work must be done under actual operating conditions.

As to the velocity of the water in the various tubes (rate of circulation), no information is available. This matter of circulation is probably exceedingly important.

Resumé of Theories

Amongst the mass of work inspected two different theories stood out. That the amount of heat transmitted per unit time per unit area of heating surface is equal to:

[A] The difference of temperature between the gases and the water, multiplied by a constant.

[B] The square of the difference of temperature between the gases and the water, multiplied by a constant.

[A] hypothesis is a simplification of Reynold's, and of Perry's work. Other simplifications and interpretations will be given.

In order to express the several hypotheses algebraicly, the following notation will be used:

H = heat transferred.
X = extent of heating surface under consideration.
S = density of gas.
V = velocity of gas parallel to heating surface.
W = weight of products of combustion (hereafter called gas).
C = specific heat of gas at constant pressure, sometimes multiplied by a constant.

*Asst. Professor Experimental Engineering, Sibley College.

t = temperature of gas.

t_s = temperature of steam and water.

T and T_s = respective absolute temperatures.

Θ = temperature difference = $t - t_s = T - T_s$.

a, b, c′, k, m, n = different constants used in order to employ equality signs, sometimes one letter will have different values. "a" generally means the resistance to the transfer of heat. Subscripts "1" and "2" denote the beginning and end of the heating surface under consideration. Napierian logarithms are transformed to common by altering the numerical value of the constant.

With our fire tube boiler, the heat lost by the gas is gained by the water. With our water tube boiler it is assumed to be so.

$$H = W \times C \times (t_1 - t_2) = W \times C \times (\Theta_1 - \Theta_2) = W \times C \times d\Theta.$$

[A–1] The most elementary form of Perry's law is called above the [A] hypothesis, as an equation it is expressed

$$W \times C \times d\Theta = K \times \Theta \times X$$

rearranging this

$$\frac{d\Theta}{\Theta} = \frac{x}{CWa}$$

which applies to an elementary area of heating surface. Adding together several of these elements, by calculus, for the extent of heating surface between planes 1 and 2

$$\log \Theta_1 - \log \Theta_2 = \frac{x}{CWa} \pm n \qquad \text{[A–1]}$$

The same result is obtained if we consider that the heat is transferred proportional to the temperature difference, the density, and the velocity. Velocity is proportional to the absolute temperature, density to the reciprocal of absolute temperature, so:

$$W \times C \times d\Theta = K \times \frac{1}{T} \times T \times \Theta \times X = K \times \Theta \times X$$

[A–2] Perry's almost complete theory is

$$W \times C \times d\Theta = K \times C_p \times S \times V \times \Theta \times X$$

in which C_p is the instantaneous value of the specific heat. Considering that C_p is proportional to the absolute temperature

$$W \times C \times d\Theta = K \times T \times \frac{1}{T} \times T \times \Theta \times X = K \times T \times \Theta \times X$$

Integrating, as before,

$$\log \frac{\Theta_1}{T_1} - \log \frac{\Theta_2}{T_2} = \frac{x}{CWa} \pm n \qquad \text{[A2]}$$

[A–3] Following the reasoning on page 111 of Bulletin 325, U. S. G. S., but assuming that friction (F) varies with the square of the velocity (as it does in non-viscous flow) we have $F = CnV^2$ instead of $F = CnV$. Assume also that C_p is a constant. Then

$$W \times C \times d\Theta = K \times C_p \times S \times \Theta \times X = \frac{K^1 \times C_p \times \Theta \times X}{T} = \frac{C\,\Theta\,X}{T}$$

$$\frac{d\Theta}{\Theta} = \frac{X}{TWa}$$

$$T_1 \log \Theta_1 - T_2 \log \Theta_2 = \frac{x}{Wa} \qquad \text{[A3]}$$

The complete law, as given by Perry, is

$$H = \frac{c'SV(t - t'')}{1 + c'SV\frac{b}{k}}$$

in which t'' = temperature of the water side of the gas film adhering to the metal or soot.

b = thickness of the gas film and

k = conductivity of the gas film.

It is possible that as V increases, b diminishes so that Vb may be a constant. mSV is the weight. If so,

$$W \times C \times d\Theta = \frac{CW\Theta}{1 + \frac{C'W}{T^3}}$$

[B] If the heat transfer is proportional to the square of the temperature difference

$$H = W \times C \times d\Theta = K \times \Theta^2 \times X$$

$$\frac{d\Theta}{\Theta^2} = \frac{x}{CWa}$$

$$-\frac{1}{\Theta_1} + \frac{1}{\Theta_2} = \frac{x}{CWa} \qquad \text{[B]}$$

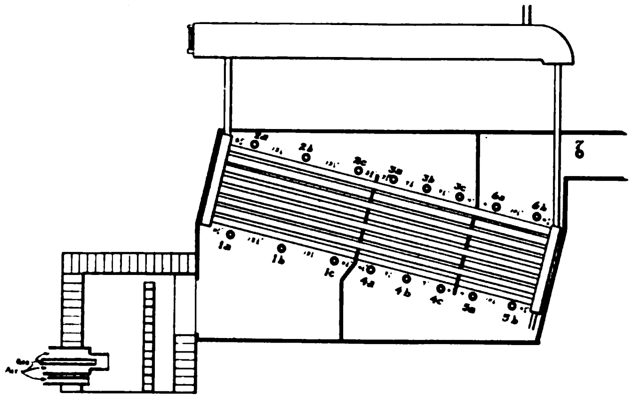


Figure 1.
Sectional Model of a Water Tube Boiler.

In handling the data, we have generally used it in a manner so that if the hypothesis is proved, the curves as plotted would be straight lines. For example A-1 is of a form so that a curve plotted with log Θ and X should give a straight line. Also $\log \Theta_1 - \log \Theta_2$ should be a constant for one set of conditions, and if plotted to corresponding values of heating surface, a horizontal line should result.

Throughout this article a straight line law ($y = mx + b$) has been considered as a direct proportionality between "x" and "y."

RESULTS

For the reasons before assigned, the results are hard to interpret. The A-1, A-2, and B hypotheses were tried out with data as taken, numerically averaged, and averaged from faired curves. Also by several other schemes. The conclusion was reached that A-1 and A-2 were both more nearly true than B.

Of the mass of data taken, a few runs have been selected for this abstract because of their representing maximum and minimum initial temperatures and weights of gas passing.

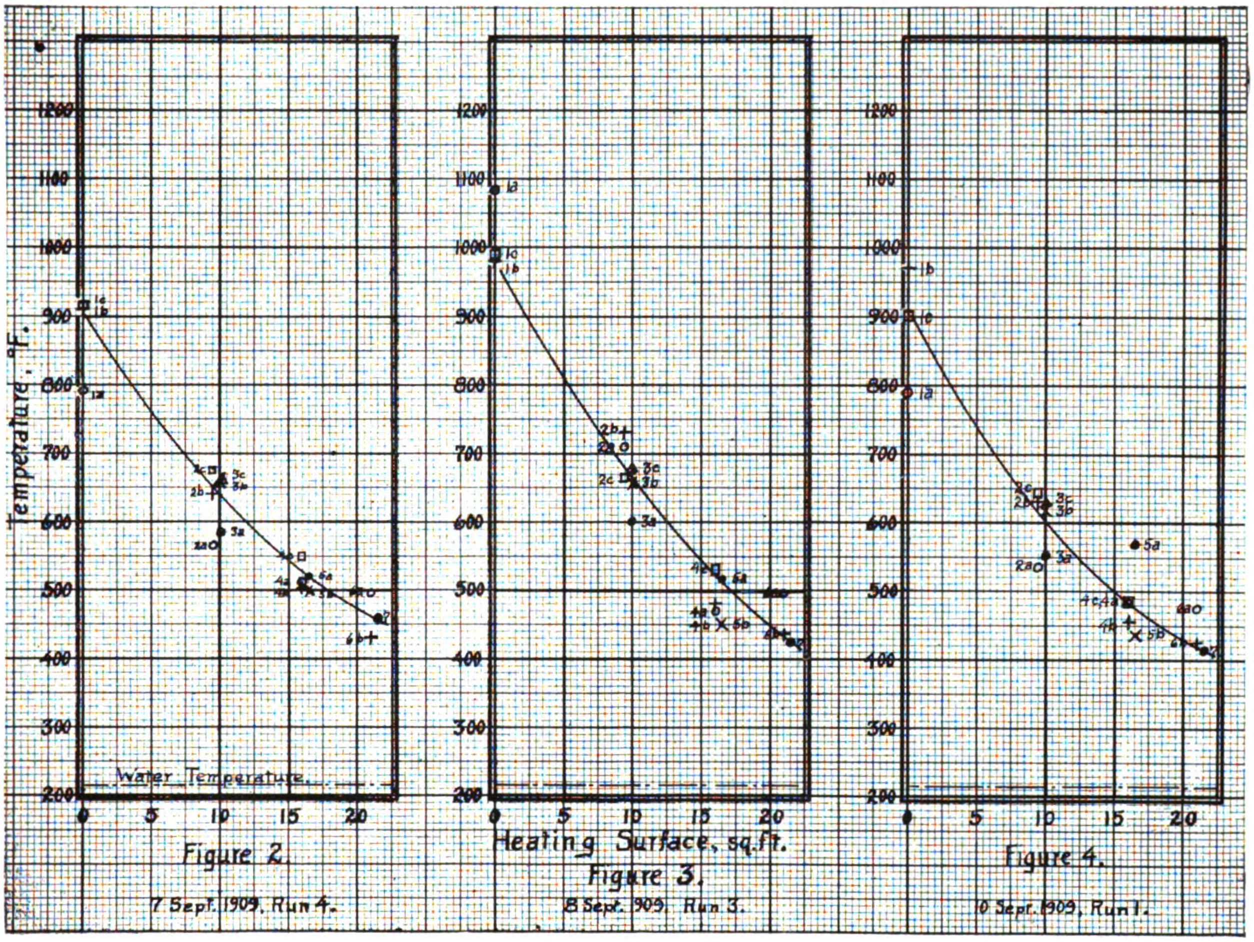


Figure 2. 7 Sept. 1909. Run 4.

Figure 3. 8 Sept. 1909. Run 3.

Figure 4. 10 Sept. 1909. Run 1.

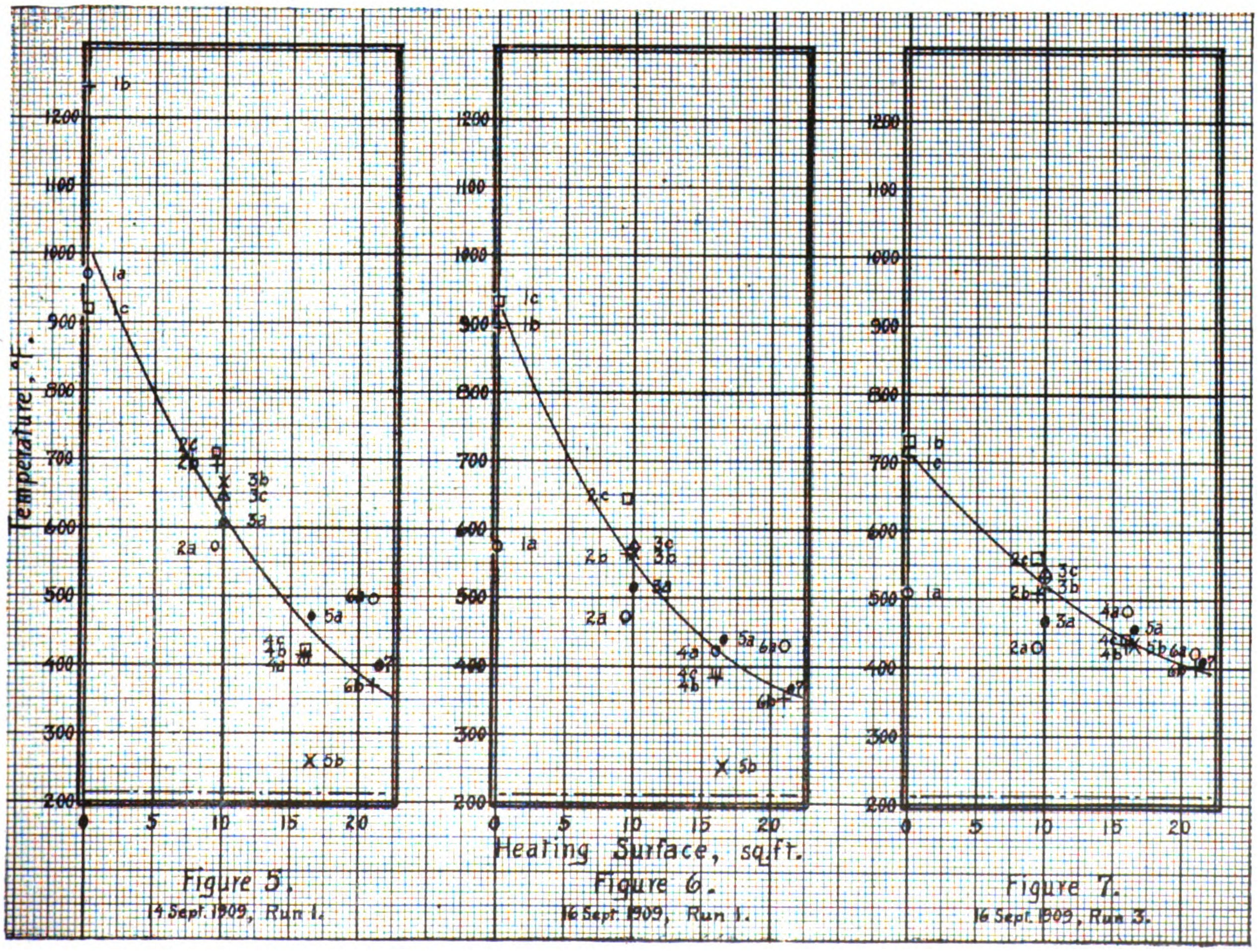


Figure 5. 14 Sept. 1909, Run 1.

Figure 6. 16 Sept. 1909, Run 1.

Figure 7. 16 Sept. 1909, Run 3.

Run.	Av. Initial Θ, F. deg.	W, lbs. per min.
7 Sept., 1909—No. 4	670	7.90
8 " " —No. 3	820	5.41
10 " " —No. 1	690	5.78
14 " " —No. 1	840	3.18
16 " " —No. 1	600	3.15
16 " " —No. 3	450	7.24

The observed temperature and total heating surface for these runs is shown by curves, Figures 2 to 7 inclusive. The temperature of the water was about

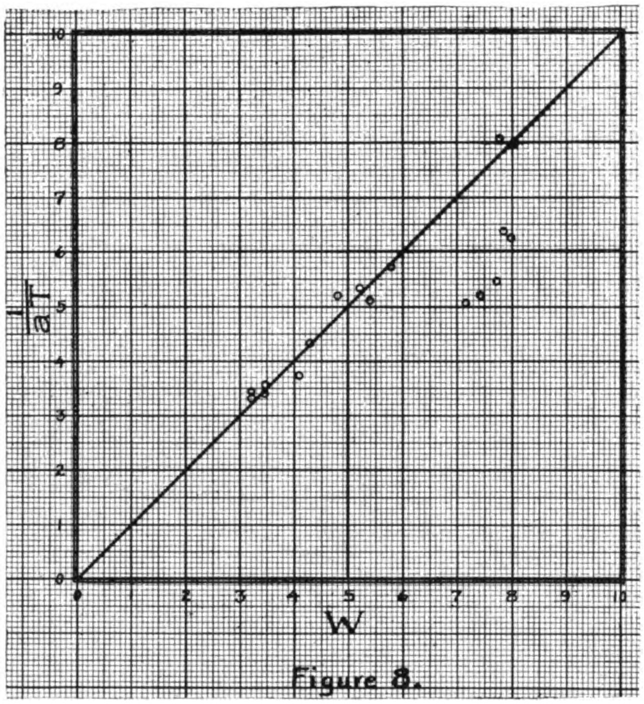


Figure 8.

214° F. Referring to Figure 1, the pyrometer locations are there shown. On the curves pyrometers or thermometers are designated by the form of the points:

1a, 2a, 4a, 6a by	O
1b, 2b, 4b, 6b by	+
1c, 2c, 4c by	□
3a, 5a, 7 by	●
3b, 5b, by	×
3c by	Δ

The three stations 1 were at entrance; the three stations 2 were after 9.82 sq. ft. of heating surface, as were stations 3. Stations 4 were after 16.23 sq. ft. h. s., as were stations 5. Stations 6 and 7 were after all the heating surface, 21.20 sq. ft.

Only one of the many other curves is here reproduced, Fig. 8. This is the relation between the weights of gas and the reciprocal of the coefficient of resistance times the velocity. The latter was obtained from the value of "a" as computed from

$$\log \Theta_1 - \log \Theta_2 = \frac{X}{CWa}$$

and then "a" was multiplied by the absolute temperature (as being proportional to the velocity), and the reciprocal then found. The points mostly lie upon the 45° line, tending to show that the resistance to the transfer of heat is directly proportional to the velocity times a constant.

The results from this boiler show very well how the gases do not always get a chance to utilize all of the heating surface. Otherwise the work is very unsatisfactory as far as determining the laws of heat transfer. So a second experimental boiler was built.

FIRE TUBE BOILER

Apparatus

The fire tube boiler, shown in Figures 9 and 10, was constructed from a 12″ wrought iron pipe about 10 feet long, with flanged ends. A 4″ boiler tube was expanded into the flanges, concentric with the pipe. Nine copper tubes 1″ external diameter were expanded into holes drilled perpendicularly through the pipe and the tube, dividing the heating surface of the tube into ten equal parts. Base metal thermo-couples were inserted through these copper tubes so that the couples were at the centre of the tube. On the 22d of April, 1910, the iron pipe guards around the pyrometers were removed and the base couples were exposed to the gas, plugs of asbestos were built up around the thermo-couples as shown in Fig. 10. Pyrometers were also placed at the two ends of the boiler tube. The boiler was equipped with water glass, feed inlet and steam outlet pipes, a small steam dome, sight glass in steam pipe for estimating moisture, etc. The steam was condensed and weighed. In operating, no data was taken until all the water was at the boiling point (about 212 to 215° F), and it was never (or seldom) necessary to supply water during a run, in order to keep the level above the tube. The boiler and steam piping were insulated with a layer of asbestos plaster, this was covered with a layer of hairfelt.

A blower supplied air thru a measuring device to a burner, mixing with city gas, also measured. The burner was of special construction. The furnace was long, with two sets of checkerwork baffles nearly to the

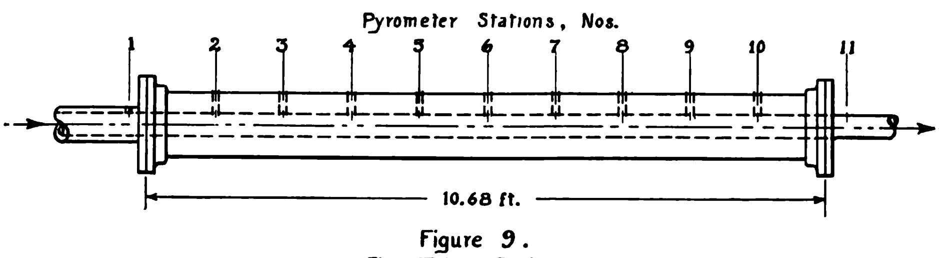


Figure 9.
Fire Tube Boiler.
Total heating surface 11.19 sq. ft., divided by pyrometers into ten increments each having a length of 1.068 ft., and an area of 1.119 sq. ft.

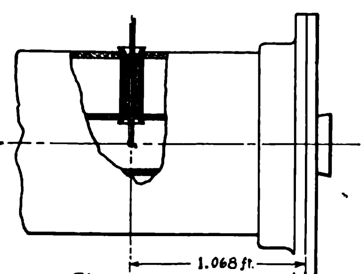


Figure 10.
Fire Tube Boiler, Detail. Showing Method of Taking Gas Temperatures.

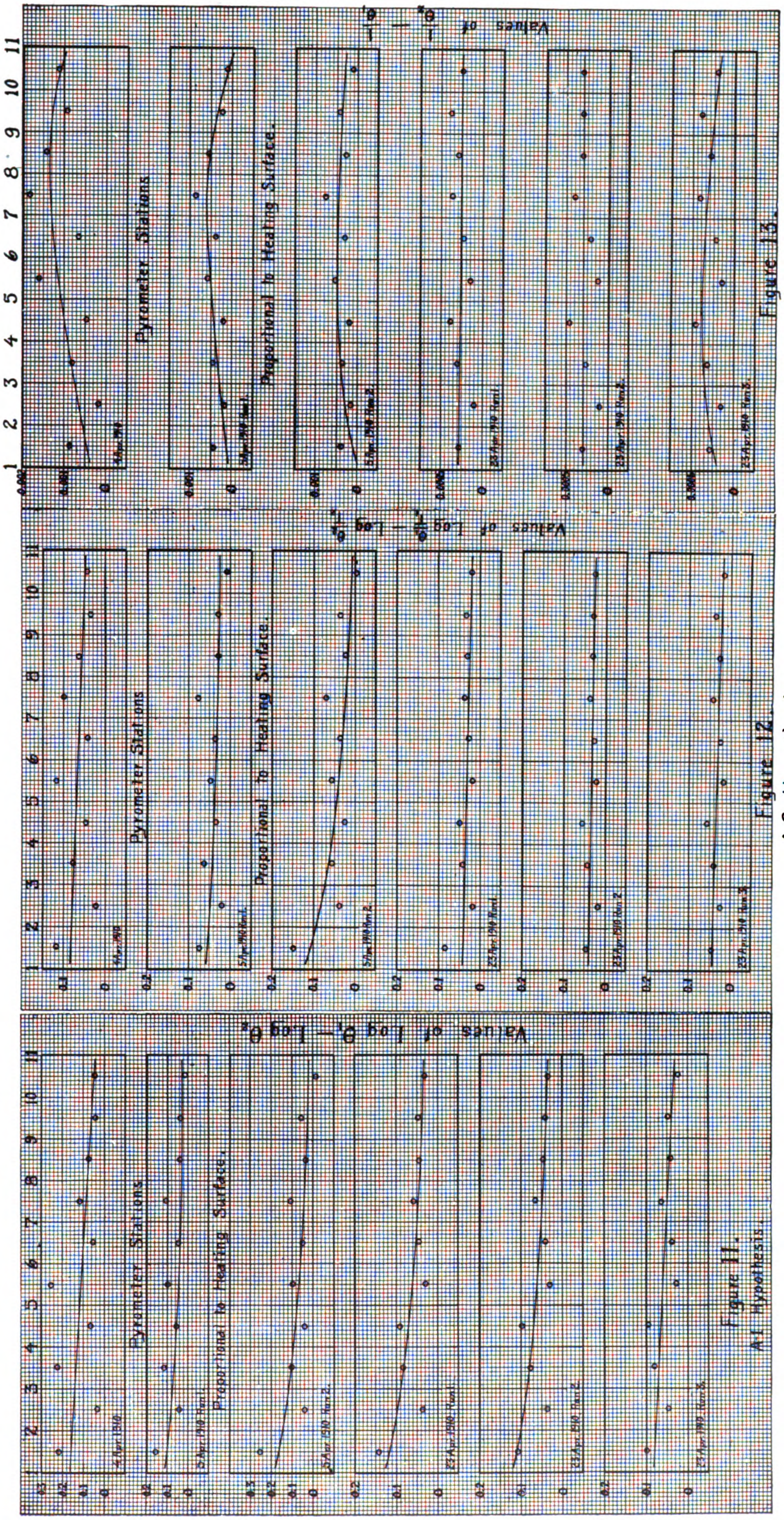


Figure 11.
A-1 Hypothesis.

Figure 12.
A-2 Hypothesis.

Figure 13.
B Hypothesis.

roof and entirely across it. The hot products of combustion were conveyed from the furnace to the boiler by a reinforced concrete and fire clay pipe 15″ long and 4″ inside diameter. Great care was taken to prevent any leakage of the gases from the system.

The thermo-couples were probably inaccurate up to a maximum error of about 25° F. low at 212°. The water of the boiler probably exerted some cooling effect on Nos. 2 to 10 inclusive. No. 1 received heat from conduction through the cement pipe, which also caused the flange on the end of the boiler to be a heating surface. Direct radiation from the flames was nearly prevented.

Preliminary Results

The A-1, A-2, and B hypothesis were used with this data, as shown on Figures 11, 12, and 13 respectively. If the data proved the hypothesis, an horizontal straight line would result from the data as plotted. None of these hypotheses are correct, apparently.

A peculiar feature shown on these curves is the regular sequence of high and low temperatures, wave-like, and dying out toward the end of the boiler. The waves are of different amplitudes with and without the guards on pyrometers. It is believed that these waves are formed by the presence of the large thermo-couples, which disturb the lines of flow. Some other less disturbing means of obtaining temperature was necessary, more concerning this later.

Expressing the idea of A-1 in other words

$$\Theta C\,Wa = (t_1 - t_2)\,CW$$

$$a = \frac{t_1 - t_2}{\Theta}$$

This coefficient "a" was found to vary nearly directly with the absolute temperature, in other words, with the velocity.

Expressing hypothesis B in a similar manner

$$\Theta^2 CWa^1 = (t_1 - t_2)\,CW$$

$$a^1 = \frac{t_1 - t_2}{\Theta^2}$$

The coefficient "a′" did not appear to follow any simple law.

As the law of heat transfer proportional to the temperature difference appeared more logical and more nearly borne out by the tests, this line of investigation was carried further by means of the curves, Figures 14 to 18 inclusive. Fig. 14 shows the relation between heat transmitted and temperature difference; a curve for the smaller temperature differences, straightening out to a direct variation for the larger values. Fig. 15 shows the same data to the same ordinates, but logarithmic scaling is used. Apparently the plot is a straight line with slope of 1.43 denoting that the heat transferred is proportional to the 1.43 power of the temperature difference. The ratio of specific heats $\left(\frac{C_p}{C_v} = \text{"gamma"}\right)$ for air and similar gases is about 1.4. This similarity may be only a coincidence. Fig. 16 shows that the heat transferred varies

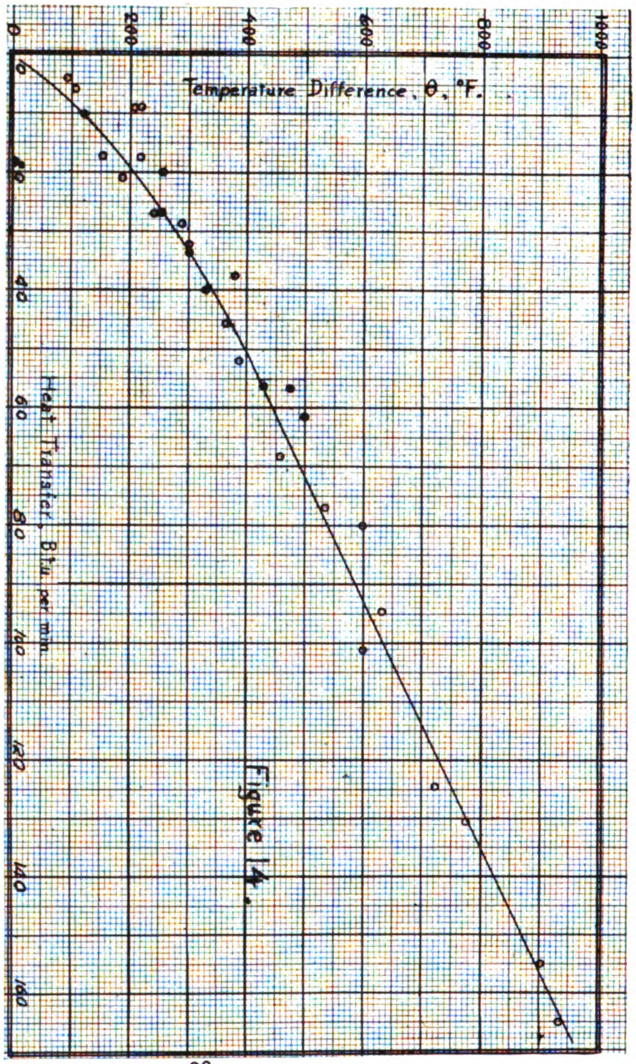


Figure 14.

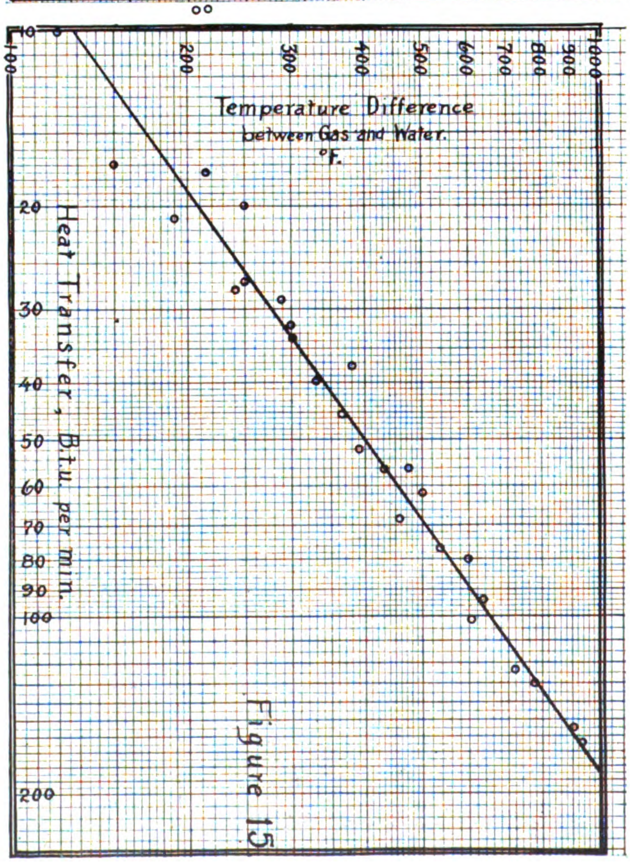


Figure 15

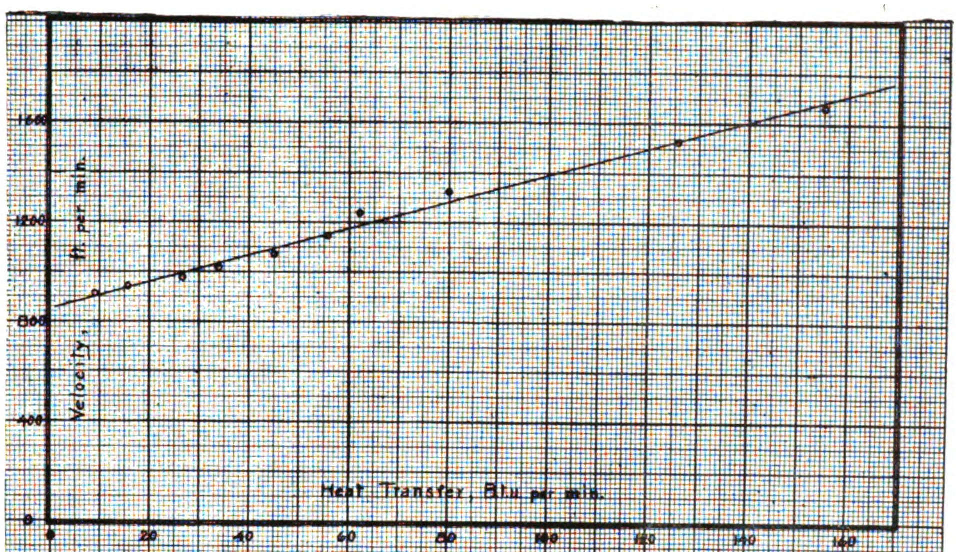


Figure 16.

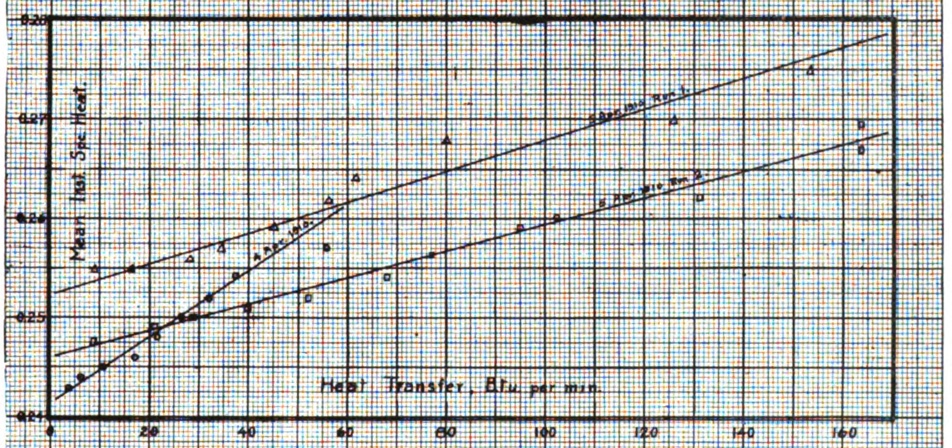


Figure 17.

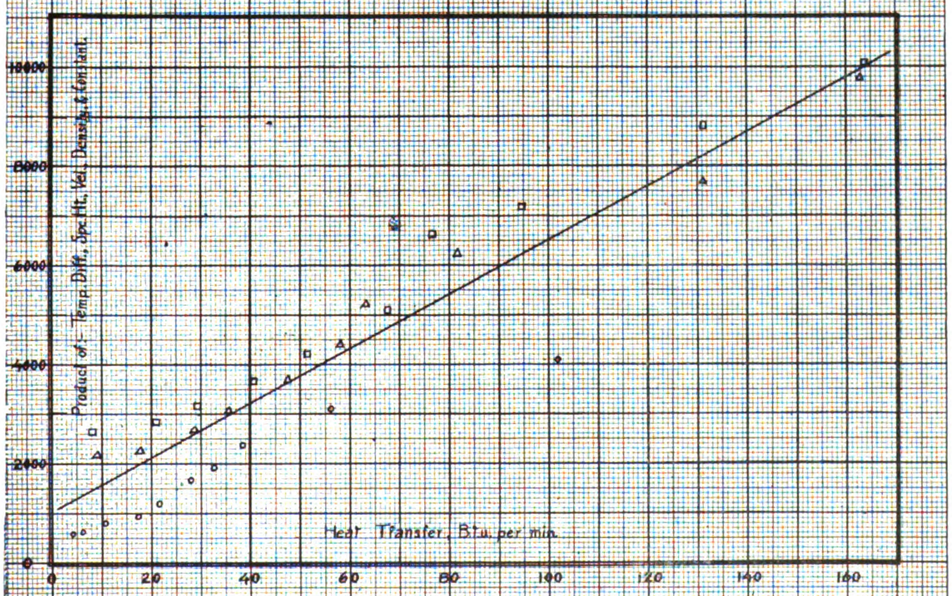


Figure 18.

directly with the velocity. The velocity as computed included correction for change of volume with temperature. Fig. 17 shows that the heat transferred varies directly with the instantaneous value of the specific heat at constant pressure, and considering the assumptions necessarily made in the computations might as well be drawn as one line. Fig. 18 is simply a check on the other three, and tends to prove this idea.

By this time we were convinced that the law stated by Perry was correct, but we had not sufficiently proved it. The pyrometers were not accurate, and they disturbed the flow.

Platinum Thermo-Couple

The base metal thermo-couples were removed and a platinum 10% rhodium couple, connected with a delicate milli-voltmeter was used, beginning in October, 1910. The "hot junction" of this couple was very small, and "spot" temperatures could be taken. It was calibrated with the cold junction at operating conditions, against a standard which had been calibrated at the United States Bureau of Standards. The standard cold junction was maintained at temperature under which it had been calibrated. Our couple was found to be about 10° C. low at 100° C. actual, correct at about 150° C, about 50° high at 500°, and 100° high at 1000° C. During any run the conditions were maintained constant and the couple was moved from station to station, the holes always being plugged except when changing the pyrometer.

Results

Figures 19, 20, and 21 are similar to Figures 11, 12, and 13. The points are from values computed from corrected temperatures at the centre of the boiler tube. A-1 and A-2 hypotheses are more nearly true than B.

The A-3 idea is tried out in a similar manner on Figure 22, and, so far, is the closest approximation to the truth.

Owing to the lack of sufficient date it was not possible to try out Perry's complete law of heat transfer. The form of this law is such that if it were true, the A-1 plots would be curves.

Traverses

When using the platinum-rhodium couple, it was noticed that the temperature indicated at any one station could be varied by changing the position of the couple in the tube. So temperature traverses were made across the tube at the various stations. Then a Pitot tube was constructed, and velocity traverses were made, nearly at the same time, and at the same conditions as the temperature traverses.

These traverses on a vertical diameter for the two ends and centre stations are shown on Figures 23, 24,

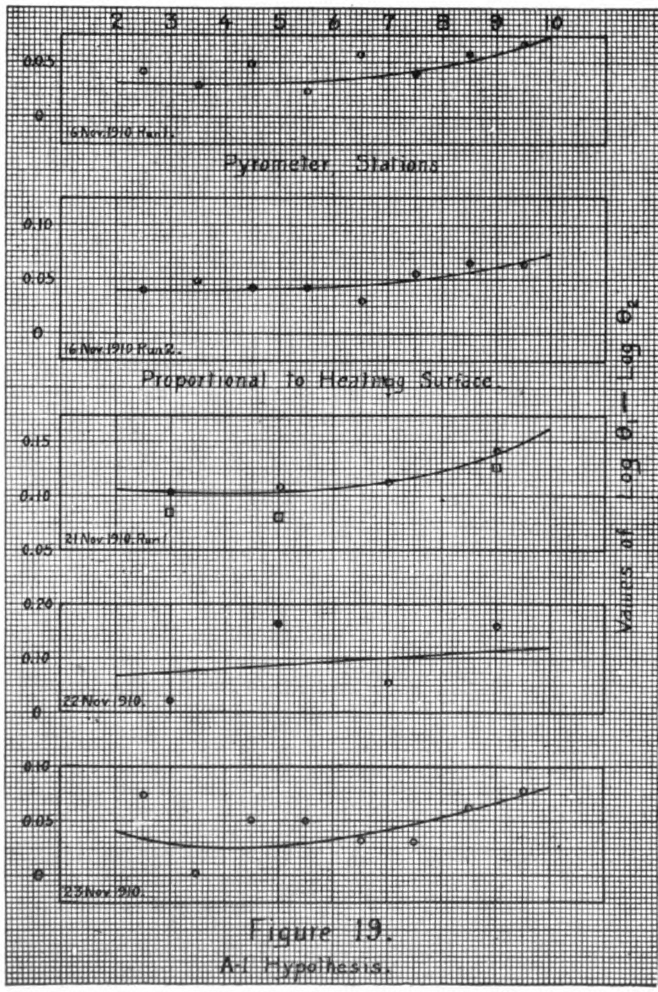


Figure 19.
A-1 Hypothesis.

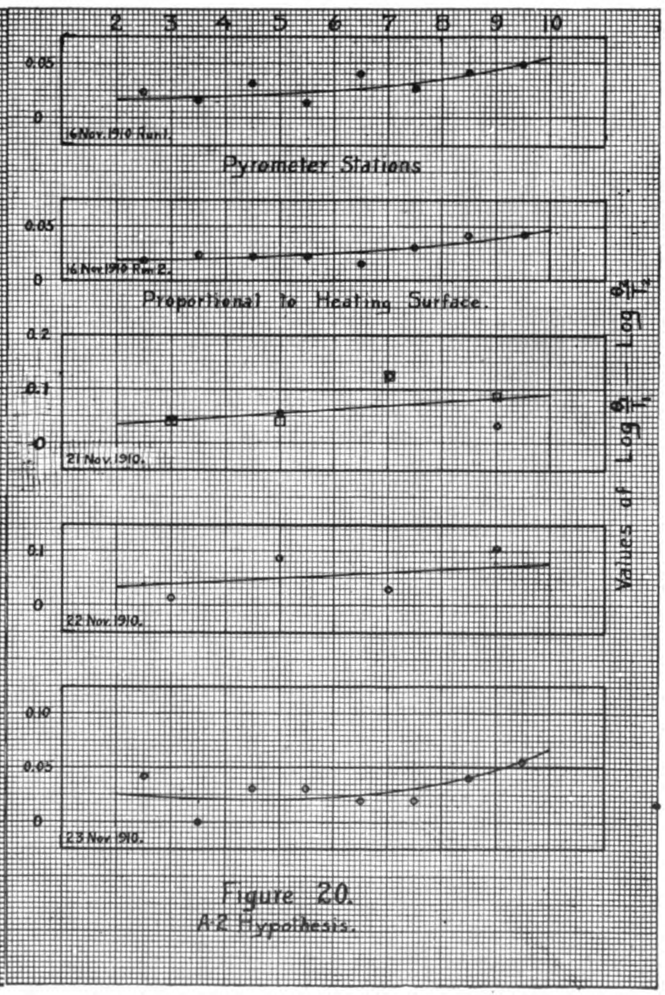


Figure 20.
A-2 Hypothesis.

and 25. The circles in connection with the upper scales are the points of corrected temperatures. The crosses with the lower scales are values proportional to the velocity (= square root of product of absolute temperature and velocity head).

The run of 21 Nov., 1910, Fig. 23 is with minimum weight of products of combustion; that of 23 Nov., 1910, Fig. 25, is with maximum weight; that of 22 Nov., 1910, Fig. 24, is intermediate. Attempt was made to keep initial temperatures the same for these three runs. The traverses shown are representative.

The traverses of temperature and of velocity were in all cases identical in form, and it was proved that the relation between the temperature and velocity was a direct proportion.

As the gases pass along the length of the tube, the point or path of maximum temperature and velocity tends to rise. Probably the gas is deflected by the ends of the copper pyrometer tubes extending slightly into the top of the boiler tube.

What Temperature?

On page 30 of Bureau of Mines Bulletin 18, "The Transmission of Heat into Steam Boilers" the question is raised as to what temperature is correct. The explanation of their temperature variation probably is the same as that of our waves (when using the large thermocouples) and includes the disturbing of the stream lines natural to the temperature traverse.

For the plots, Figures 19 to 22 inclusive, the temperature at the centre was used. This is not correct, nor would the maximum temperature at the station be correct. The numerical average of the temperatures representing equal areas would not be correct, because it would not be certain that higher velocities with greater mass would neutralize the higher temperatures with smaller mass of gas passing per unit time.

Something similar to the "pipe factor" of a velocity traverse must be used, which gives due regard to the weight of gas having a certain temperature, in other words, the mean, or average, mass temperature must be used. This was obtained by dividing the tube into small equal areas. Determining the mass flowing through each elementary area per unit time, which involved the density change with temperature (neglected change of density with pressure). Finding the temperature of this elementary mass and multiplying it by the mass. And then summing up all the elementary mass-temperature products, so obtaining the average

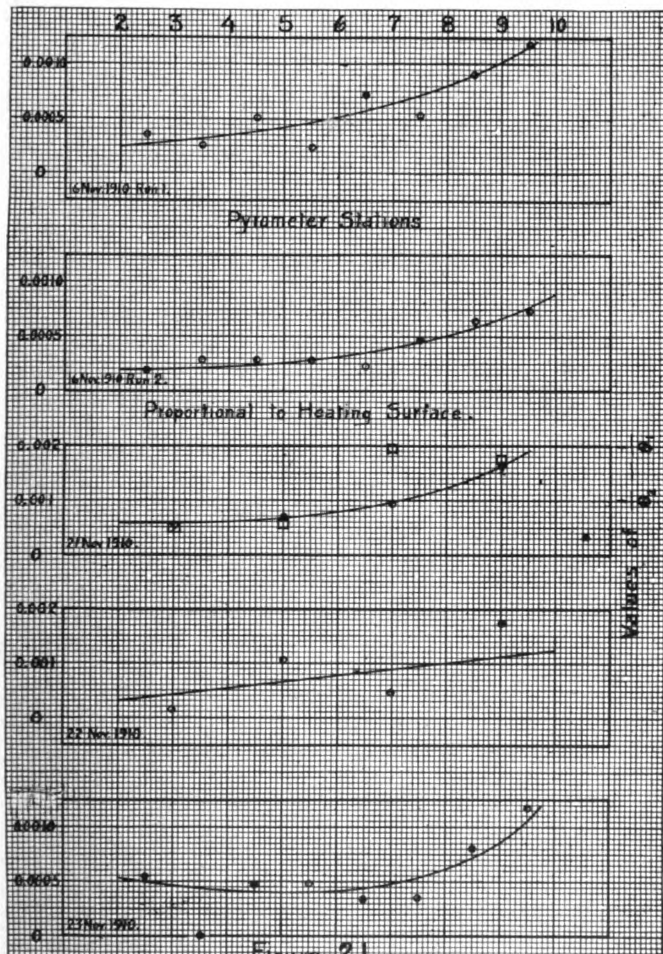


Figure 21.
B Hypothesis.

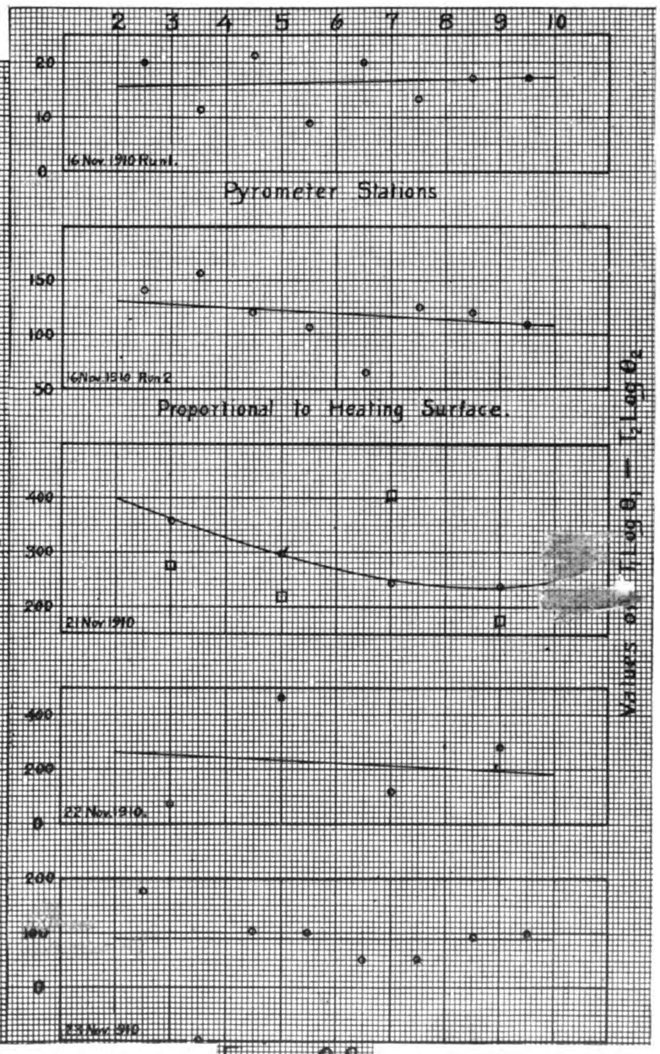


Figure 22.
A-3 Hypothesis.

temperature of the total mass. Omitting the derivation, the Mean Mass Temperature is found to be

$$\frac{\Sigma\,(H\,T)^{\frac{1}{2}}}{\Sigma\,(\frac{H}{T})^{\frac{1}{2}}}$$

in which

H = velocity head, as measured in inches of water, at each elementary area.

T = absolute temperature of gas at each elementary area.

This mean mass temperature was computed (on the same basis as the "10 point" method) for the run of 21 Nov., 1910, and the results shown by the squares on Figures 19 to 22 inch. Evidently the result is not greatly different from the temperature at the centre, so no further work was done upon this Mean Mass Temperature basis.

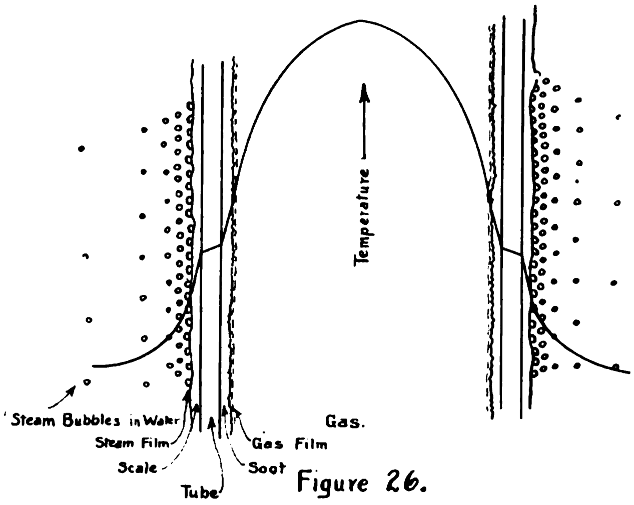
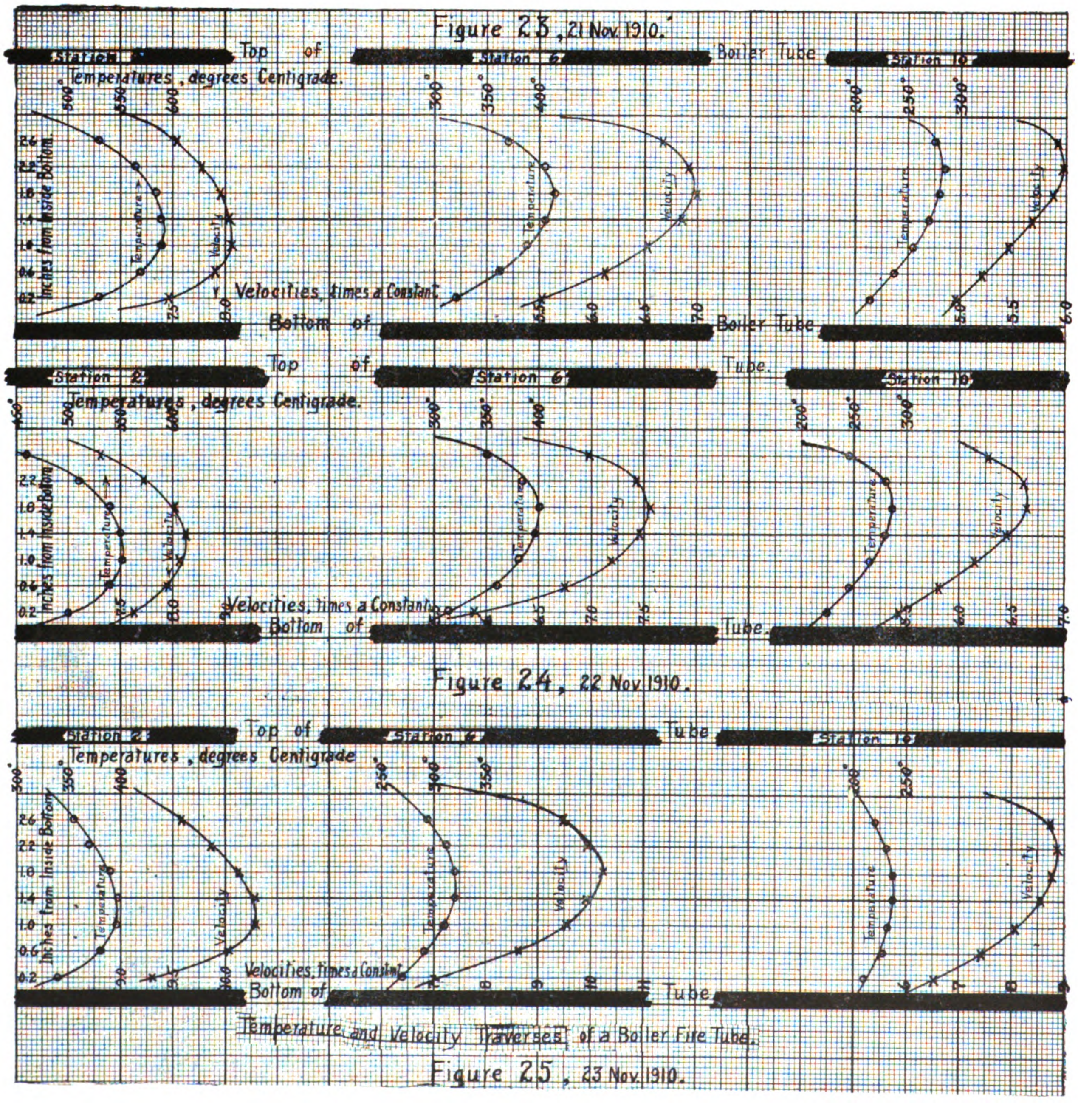


Figure 26.

Diagram illustrating the Temperature Gradient thru Gas and Solids, and Water, in a Boiler Fire Tube.

Remarks and Conclusions

In all of the works upon this subject of heat transmission the starting point is the film of gas which clings



to the soot on the metal, see Figure 26. The temperature traverses indicate that the entire cross-section of the gas in the boiler tube must be considered, as well as the gas film, soot, metal, scale, steam bubbles, and water.

The gas flowing through a boiler tube does not follow the laws of viscous flow, but is in the condition of turbulent flow. In none of the theories of heat transmission so far inspected has this factor been properly considered. Heat is not conducted from the hotter to the colder portions of the gas according to the laws of conduction applying to stationary gas. Viscous flow would permit stationary gas conductivity laws to be applied. Turbulent flow has no definite laws, in so far as our present knowledge goes. Perry's scheme of trying to account for it by friction is the nearest approach to the truth. A similar line of reasoning applies to the carrying away of the heat by the water in the boiler, but in a fire tube boiler the water side is more complicated.

Each of the theories of heat transmission studied may be derived from the Kinetic Theory of Gases by the omission of certain terms of the kinetic theory. One investigator has laid more stress upon one factor, another man upon another factor; thus giving rise to the large number of apparently conflicting theories. The laws of turbulent conductivity (when found) must be used in connection with the kinetic theory.

It is our opinion that the true laws of heat transmission must be based upon this Kinetic Theory. The less important factors must be determined by careful and exhaustive experiments, and in that manner a more or less simplified law may be developed, which, with certain constants, will cover the range of steam boiler practice.

THE QUEBEC BRIDGE

H. A. PIDGEON*

Quite frequently during the past several years and especially within the last few months, has the interest of the engineering profession been directed toward the Quebec Bridge, which was to have been completed about September 15 with the hoisting into position of the central swing span, 640 feet in length and weighing approximately 5200 tons.

Had this been accomplished it would have completed the longest and heaviest single span cantilever bridge in the world. The construction of the great structure had gone forward with marvelous precision and smoothness until on September 11 the central span, which was being lifted into position, suddenly slipped from its suspensions and plunged into the river which at this point is 200 feet deep. Over 50,000 spectators had gathered on the river banks to watch the great engineering feat and the ceremony incident thereto, and were horrified at the catastrophe which precipitated a large number of workmen into the water, eleven of whom lost their lives.

A few days prior to the accident of September 11, the writer of this sketch was shown the interesting features of the structure by Mr. N. C. McMath, a graduate of the Cornell College of Civil Engineering, who is one of the construction engineers. Through his courtesy photographs were taken, some of which are shown in the accompanying figures.

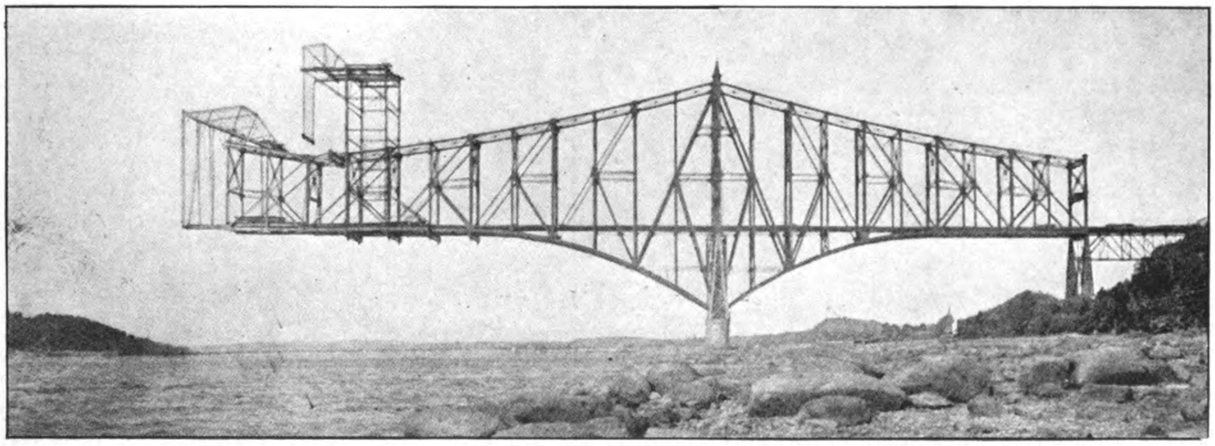


FIG. 1

There has long been a great demand for a bridge across the St. Lawrence river at Quebec, since it would materially lessen the trans-continental distance across Canada, form an important link in the system of Canadian Government Railways, make Quebec easily accessible to the main lines of the Canadian Pacific and Grand Trunk railways, and vastly increase its importance as a commercial center.

Garneau point which is eight miles above Quebec is a strategic site for a bridge. The St. Lawrence at

*Instructor in Physics, Cornell University.

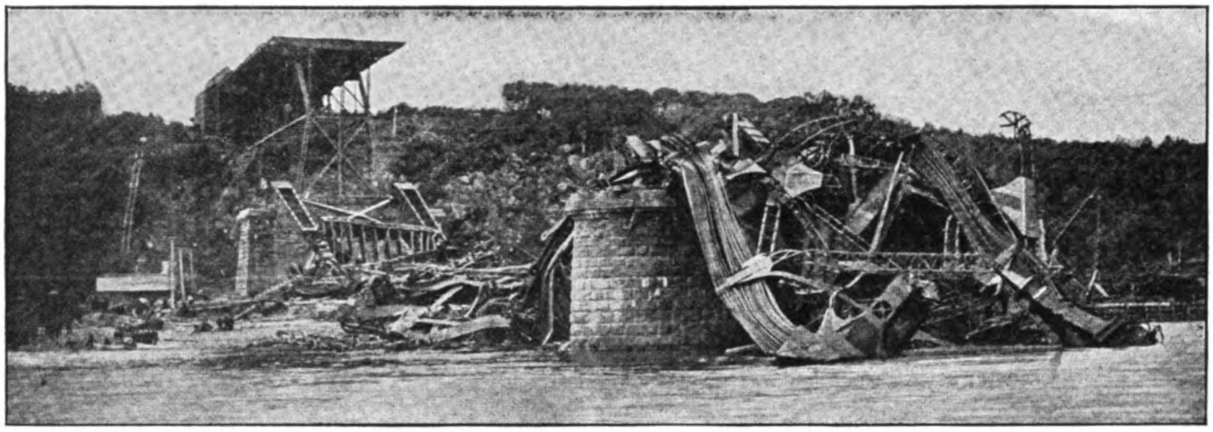


FIG. 2

most places in this region is very wide and sufficiently deep to make the building of piers very expensive. Here, however, the river narrows down to about 1800 feet, but its great depth precludes the possibility of building piers in the river; hence, cantilever construction is necessary.

As early as 1885 plans were made for a bridge at this place but nothing came of it. In 1900 a contract was let to the Phoenix Bridge Company, one of the oldest and most experienced bridge companies in America.

The structure was to consist of a channel span 1800 feet long and two anchor spans each 500 feet in length, making the total length between anchor piers 2800 feet. The channel span was to consist of two cantilever arms each 315 feet high over the main piers, and 562½ feet in length, connected by a suspended span 675 feet long. The entire channel span was to be built by continuous cantilever construction from each of the main piers to the middle of the river. Fig. 1 shows the southern half of the bridge with anchor and cantilever arms completed and the suspended span partially erected as it appeared shortly before the collapse. Fig. 2 shows the wreckage after the catastrophe of August 29, 1907, in which 75 men were killed.

The cause of the disaster was the subject of a great deal of discussion in engineering circles, and indeed for a time cast a doubt upon the whole field of bridge engineering. A subsequent investigation by a commission of engineers appointed by the Canadian government, showed conclusively that the failure was due to the buckling of lower chord members in the anchor span near the main pier. Tests upon very large models of these members proved that they were inadequate to withstand the enormous stresses to which they were subjected during the process of construction.

However, so imperative was the demand for a bridge at this place, that the Canadian government, which was vitally interested, took up the project and finally awarded the contract for an entirely new bridge to the St. Lawrence Bridge Company of Montreal for $8,650,000 making a total of $12,000,000 including substructure. (It is reported that the total cost of the new structure complete will reach nearly $17,000,000.)

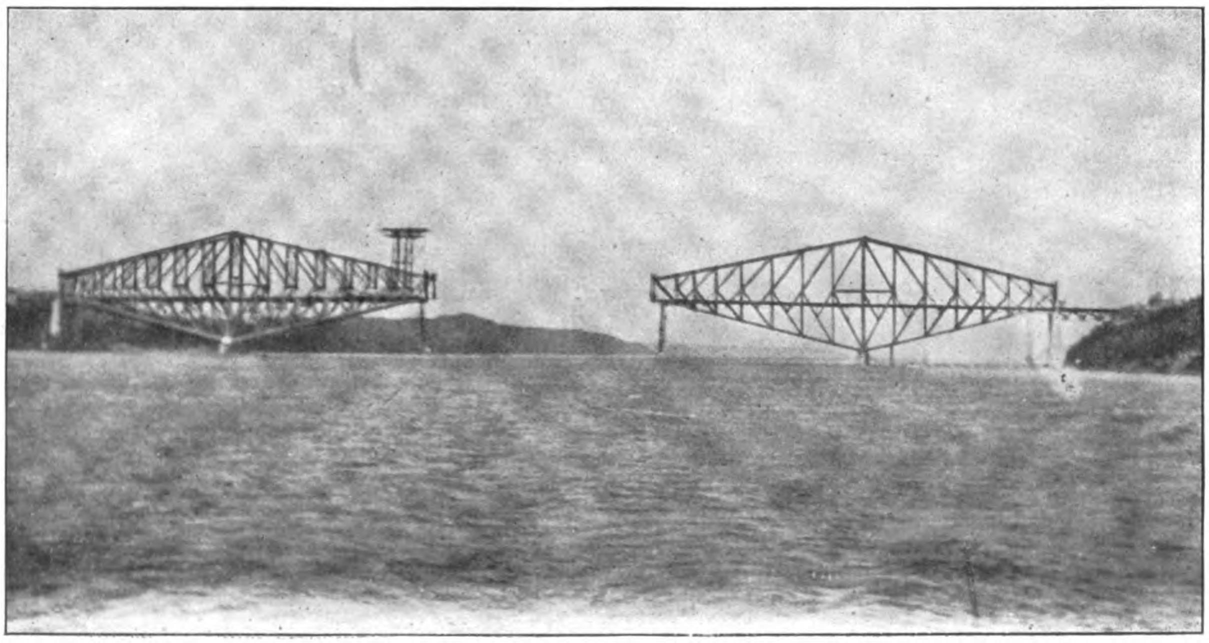


FIG. 3

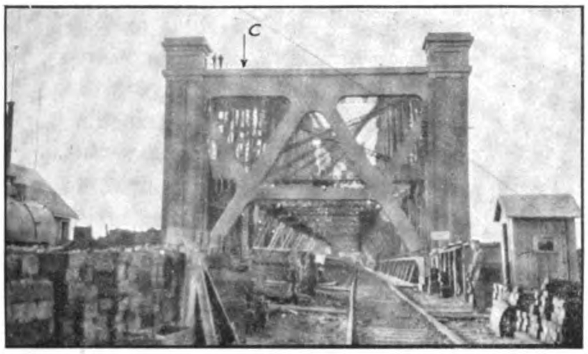


FIG. 4

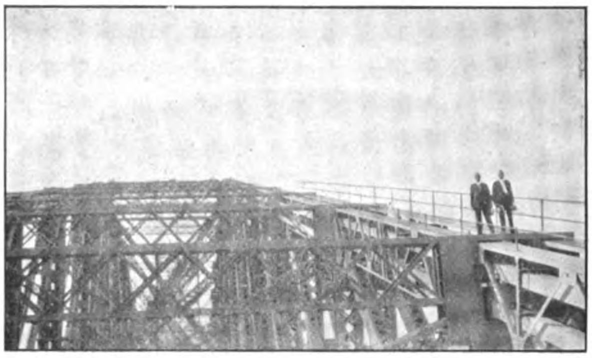


FIG. 5

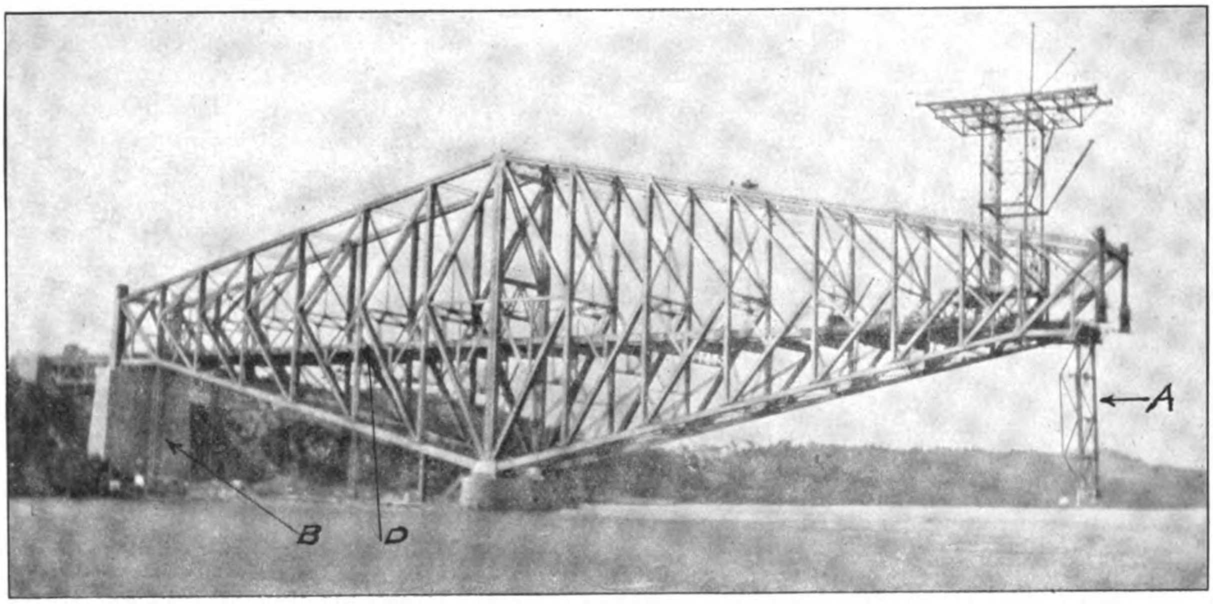


FIG. 6

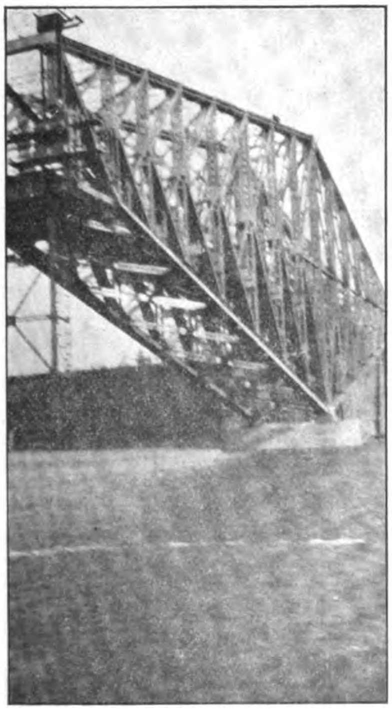


FIG. 7

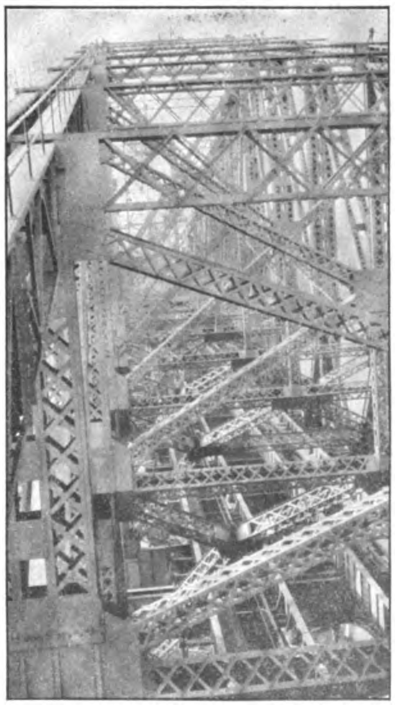


FIG. 8

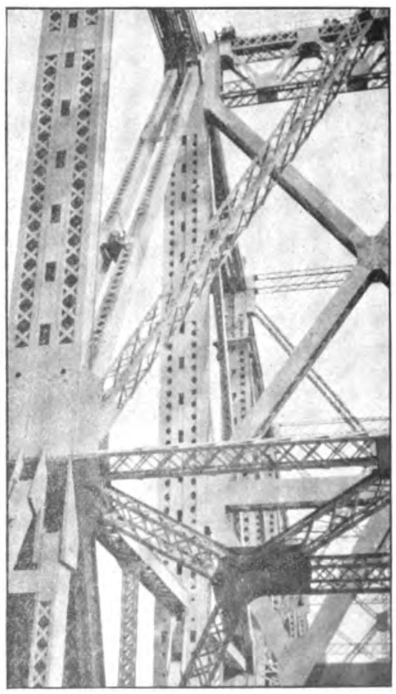


FIG. 9

In general design it differs very materially from the first bridge although the general dimensions are not far different. The channel span remains at 1800 feet, although new and heavier piers were built. It is to consist of two cantilever arms each 310 feet high over the main piers and 580 feet long, connected by a suspended span 640 feet in length. The anchor arms are each 515 feet long and with approach spans makes a total length of 3228 feet. The trusses are 88 feet apart and there is to be a clear head room of 150 feet above extreme high water.

The new structure differs in two important particulars from the old. It is far heavier, requiring about 70,000 tons of steel in its construction, whereas the old required but 40,000 tons. Moreover, the central span, instead of being built in place by continuous cantilever construction, was to be built elsewhere, floated to place on specially constructed steel barges, and hoisted into position by eight powerful hydraulic jacks each capable of lifting 1,000 tons or more.

Fig. 3 shows the bridge as it appeared a few days before the accident of September 11. Fig. 6 shows the southern cantilever and anchor arms, with the traveler for construction purposes still in place, but being dismantled at the time. At A is shown one of the mooring trusses to hold the central span in place while hoisting. This may also be seen in Fig. 3 and Fig. 7 which with Fig. 6 were taken from the steamer Montreal en route to Quebec. At B may be seen one of the several steel columns acting as temporary supports during construction when the distribution of stresses is far different from what it will be in the completed structure.

Fig. 4 shows the southern portal with its immense posts which are, in fact, merely steel shells enclosing several very heavy eye-bars which anchor this end of the structure to the massive masonry below. At the right may be seen a Canadian trooper on guard duty.

Fig. 5 is taken from point C Fig. 4 and shows the heavy eye-bars in the upper chord supported by light latticed girders.

Fig. 8 taken from the same position as Fig. 5, gives perhaps a better idea of the magnitude of the various members, especially if one uses the figures of the men and the derrick at the center as a means of comparison.

Fig. 9 taken from near point marked D, Fig. 6, shows the top portion of the main post, which is about 300 feet long and approximately ten feet square. At its lower end it is connected to the shoe on top of the main pier by a bearing 45 inches in diameter, accommodating a 30 inch pin with its heavy bushing. Here again the man and the railing on top make a convenient means of comparison.

Fig. 10, taken from the Engineering Record, shows the central span being raised into position and was taken just a few moments before the failure. The accident seems to have been due to the failure of one of the castings supporting the corners of the span temporarily during the process of hoisting. This allowed that corner to slip from its suspension thus precipitating the whole central span into the river.

Although the failure was undoubtedly a great disappointment to those connected with the construction, it must be regarded simply as an accident that could not possibly have been foreseen and in no way reflects discredit on the design. In fact, by subjecting the main trusses to a most severe test, it proves the stability of the structure.

No doubt a new central span will be built and placed in position during the next season, thus completing the longest and heaviest span in the world. The nearest approach to it in length is the Forth Bridge, Scotland, which has two spans each 1,710 feet long but weighing only 11,575 tons each and having far less carrying capacity.

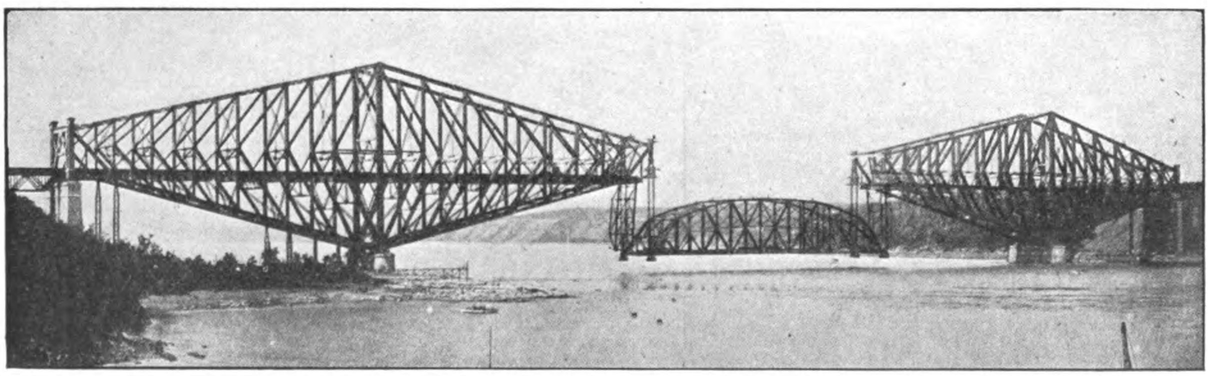


FIG. 10

EFFECT OF VENTILATION ON THE HEAT DISSIPATED FROM THE EXTERNAL SURFACE OF FIELD COILS

By GEORGE D. FLOYD*

In an article in the October number of The Sibley Journal, reference was made to the fact that, in comparison with the importance of the subject, very little had been done toward obtaining detailed information on the effect of ventilation on the heating of electrical machinery. It was the purpose of an investigation just started, to determine the relative effect of the various methods of ventilation used in practise, on the amount of heat dissipated from the external surface of field coils, for a given temperature rise.

Previous investigations on the heating of field windings have been concerned chiefly with the internal

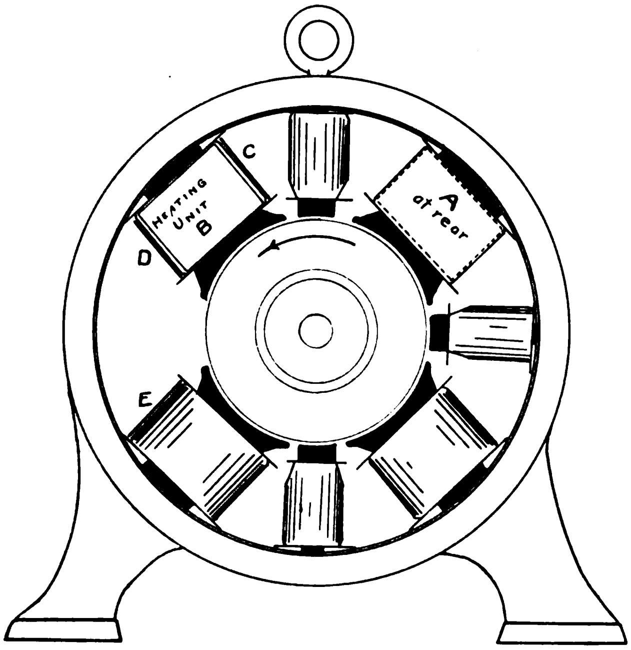


Fig. 1

temperature and the temperature gradient. Since, however, the greater part of the heat generated in the coil is dissipated from the external surface, the factors affecting the amount of heat dissipated by each portion of this surface are important. The method of ventilation, i. e., whether radial, axial, or a combination of these, the presence or absence of interpoles, or the design of the field coil itself, affect what may be called the distribution of heat dissipated.

Preliminary tests on this subject were made on a 5 H. P., four pole, semi-enclosed, interpole D. C. motor, provided with a fan on one end of the armature, as well as with radial vent ducts, so that its normal ventilation was a combination of the radial and axial methods.

*Instructor in E.E., Sibley College.

The field coils themselves did not carry current. Heating units consisting of No. 24 d. c. c. wire, wound on flat strips of fuller board, were attached to the external surfaces of the coils, and the heat dissipation and the temperature rise of these coils gave the data desired. The position of these coils is shown in Fig. 1. In order to determine the effect of the interpoles on the ventilation, one interpole was removed.

These heating coils were connected in series, and a steady current was passed thru them, of sufficient value to cause a temperature rise of about 100° C. at standstill. The machine was driven at no load by an auxiliary motor, and the average temperature rise of each coil was determined by increase of resistance for various speeds with:

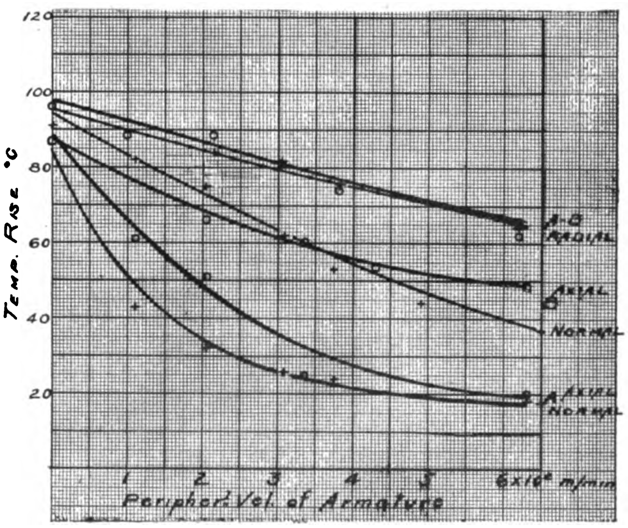


Fig. 2

1. Radial ventilation
2. Axial ventilation
3. Normal ventilation.

Radial ventilation was obtained by removing the fan, and axial ventilation by stopping up all armature vent ducts.

SUMMARY OF RESULTS

Fig. 2 shows the test data from coils "A" and "B"—"A" being placed on the side of the field coil nearest the fan, and "B" at the commutator end. The curves for coil "A" come considerably below those of coil "B" for both normal and axial ventilation, due to the fact that the air in the neighborhood of coil "A" is very greatly disturbed by the action of the fan. With radial ventilation the heat dissipated from each end of the field coil is practically the same.

It will be noticed, further, that the curves for normal and axial ventilation for coil "A," nearly coincide. The fanning effect of the armature on the ends of the field coils is due largely to the air currents set up by the fan action of the armature end connections, and this factor is not eliminated by closing the vent ducts.

Fig. 3 shows the test data from coil "C," located on the face next to the interpole. The curves for axial and normal ventilation are again practically coincident.

As the curves for coil "C" were obtained with the machine running light, the interpole winding being cold, the conditions for the dissipation of heat were better than would actually be realized if the machine were running under load, when radiation to the interpole would be eliminated. This should prove an interesting subject for further investigation.

Fig. 4 shows the data obtained from coils "D" and "E." The latter coil runs much cooler due to the fact that, with the direction of rotation of the armature as indicated in Fig. 1, the air blows directly on this coil. If the direction of rotation were reversed, coil "D" would be the cooler. Since the effect of the rotating armature itself is the same for both the axial and normal curves, the difference between these two curves must be due to the effect of the air from the vents.

The test data has been replotted in Figs. 5, 6, and 7, so as to reduce all the data to the same basis of heat dissipated per unit of surface.

The curves for coils "A" and "B" have a slightly higher value at standstill, than the other three. This is probably due to the fact that these coils are able to radiate more heat per unit area than the other coils. This is especially true in comparison with coils "D" and "E" since the latter are facing each other, and are at nearly the same temperature, so that the radiation from both will be small.

Considering the curves for normal and axial ventilation, those of coil "A" give much higher values for watts dissipated. The reason for this has already been explained. The curves for coil "D" lie below those of coil "E". Higher values,—for a given peripheral velocity—of watts dissipated per sq. cm. for 1° C. rise are obtained with normal than with axial ventilation. This is due to the fact, as has been pointed out

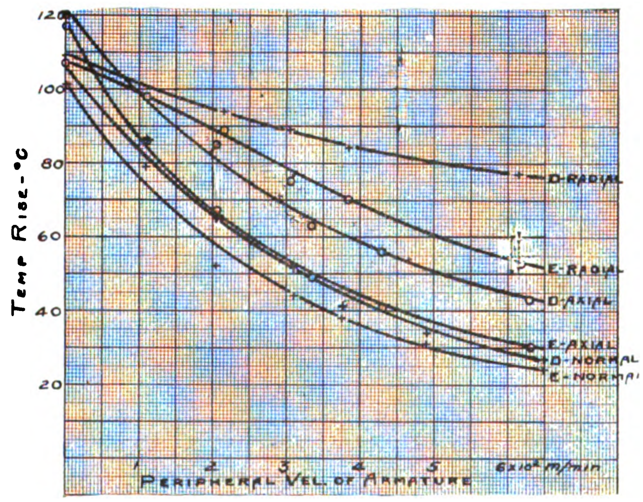


Fig 3

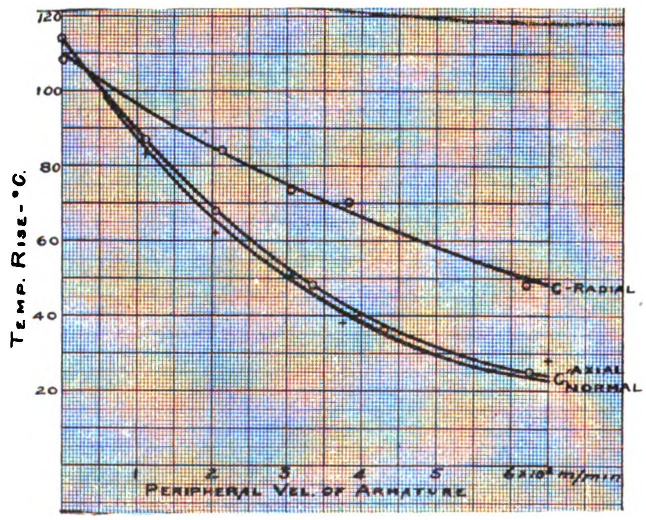


Fig. 4

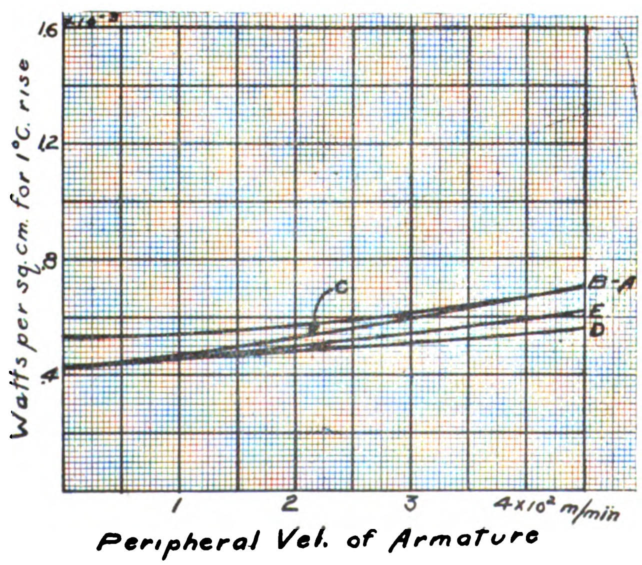


Fig. 5

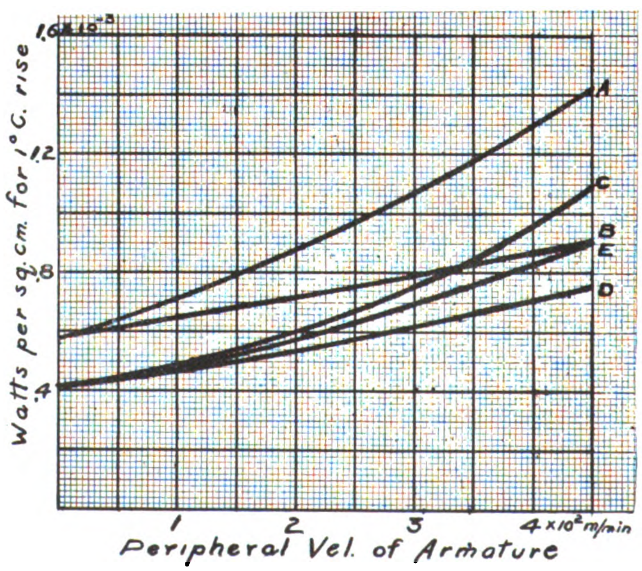


Fig. 6

above, that the cool air from the armature vents assists materially in the heat dissipation.

The curves for coil "C" are interesting in that they do not appear to follow the straight line relation which holds for the other curves, although in Fig. 6 where radial ventilation alone is present, the curve for this coil is a straight line. For normal and axial ventilation, the curves for this coil show a higher value for watts dissipated, than is the case for the similar coils "D" and "E."

The theory has been advanced by some designers, that the effect of the interpole was to decrease the watts that could be dissipated per unit area of external surface, due to the fact that there was a more restricted area thru which the air could pass. The curves obtained show that the opposite is true; and this may be explained by the fact that the restricted space allows for more intimate contact between the air particles and the surface of the coil, than would be the case if the interpole were not present, thus allowing more heat to be dissipated. It is reasonable to suppose that this effect should be more predominant at high than at low velocities, which would explain the shape of the curve.

The curves shown in Fig. 7 lie quite closely together, the curves for coils "A," "B" and "C" being practically coincident. These coils seem to have better heat dissipating qualities than coils "D" and "E", probably due to the fact, already pointed out, that since coils "D" and "E" are facing each other, and at approximately the same temperature, the radiation from them will be small.

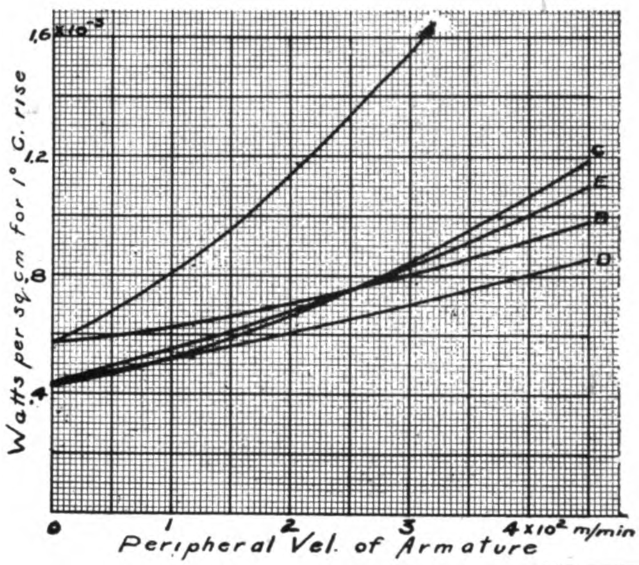


FIG. 7

The results obtained cover but a small part of the general subject of field coil heating. The effect of the temperature of the armature and interpole has not been investigated on this machine, and the only excuse for the report of an incomplete investigation is that it gives information on some of the points described in Prof. Gray's paper in last month's issue.

NEW THOMAS 135 H. P. AEROMOTOR

By RAYMOND WARE

With a new industry within our midst, it may be of more than ordinary interest to our readers to be able to describe the product of the Thomas Aeromotor Company, Inc., Ithaca, N. Y., who are now placing on the market a new small bore high speed eight-cylinder "V" type Aviation Motor, which incorporates many novel features despite its simplicity. Added interest may be claimed for this motor, as it is without doubt the smallest and most compact motor of its horsepower made in this country to-day. Although it develops in excess of 135 H.P., at which it is rated, it is but 36 inches in length between front and rear gear cover plates and 28 inches maximum width, and weighs but 600 pounds.

In general appearance the new engine is not unlike the conventional eight-cylinder 90 degree motor car engine. The cylinders are L head design, four inch bore, five and one-half inch stroke, with two and one-eighth inch valves of tungsten steel. A feature in the cylinder design which stamps the engine as different from motor car practice is the water cooling of the valve caps, access being had to them by the removal of aluminum cover plates.

The valve springs are of large diameter and of fairly heavy section to prevent the floating of the valve at top speeds. Other details of the cylinder design which are worthy of attention are the generous proportions of the cylinder feet and the closeness of the studs to the cylinder barrels. The method of holding the push rod guides in an extension of the cylinder feet also is interesting.

In working out the design of the valves and manifolds, particular attention has been given to secure accurate action and high volumetric efficiency. The push rods are of square section and work in broached aluminum guides. They are acted upon directly by the cams without intermediate rockers or followers and are drilled hollow to secure light weight.

An aluminum intake manifold is used, which is fitted to a two-inch, double-barrel Zenith carburetor. One nozzle and jet takes care of one bank of cylinders and efforts have been made to eliminate bends in the gas passages. The result of this installation is shown in the economy which is claimed to be a consumption of but thirteen and one-half gallons per hour. One water pump is used with a Siamese outlet to the

cylinder jackets. The self starter is located in the V with its shaft extending through the gear housing and carrying on its outer end the centrifugal water pump motor. Two Dixie magnetos are used running at crankshaft speed with two spark plugs per cylinder.

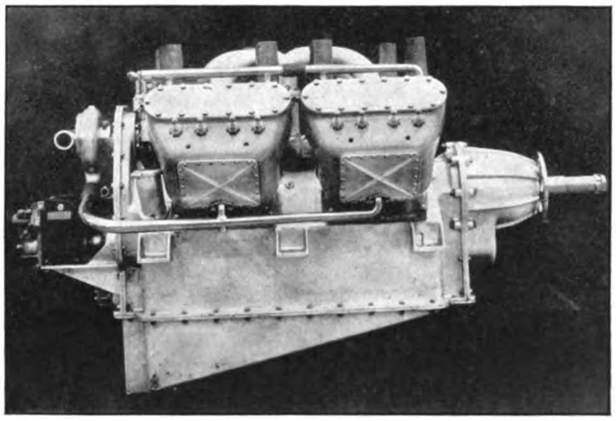


FIG. 1. Thomas Aeromotor showing layout in side elevation.

The crankcase is cast of a special grade aluminum alloy. It will be noted that it is of unusual deep sided section, being carried down considerably below the crankshaft. This has been done to insure additional rigidity. The inside of the crankcase is thoroughly webbed transversely, not only at the bearings, but also between them. This has been found necessary

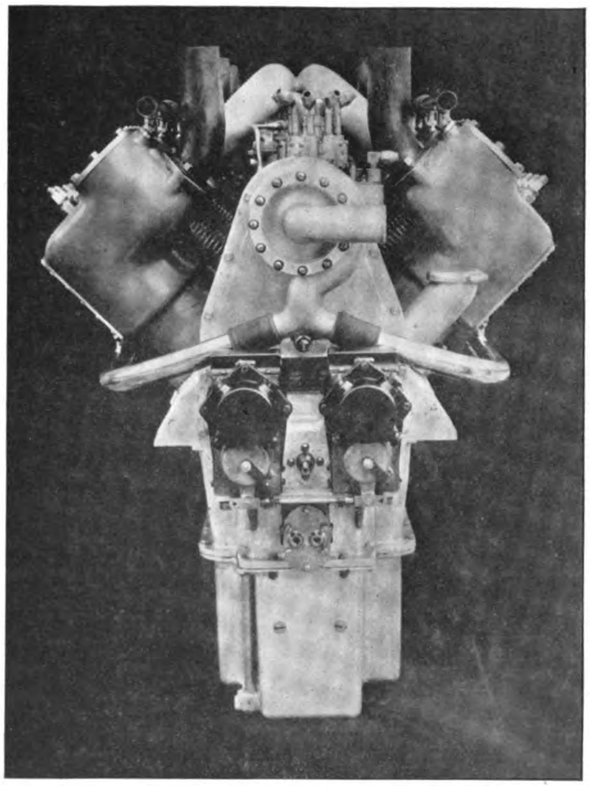
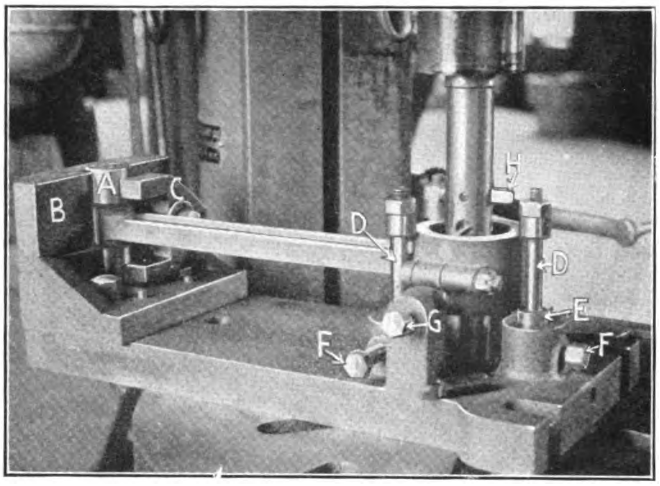


FIG. 2. This end view shows the magneto disposition and siamesed outlet from the centrifrugal water pump.

to provide a rigid base for mounting the cylinders on to prevent weaving and consequent oil leakage.

Oiling is by force feed with the lubricant delivered at 60 pounds pressure. Crank pins, webs and main journals are drilled so as to carry oil to the lower connecting rod bearings which are arranged side by side. The pistons, which are of a special aluminum alloy, are lubricated by oil thrown from the crankpins, and in order to maintain the oil temperature within the proper limits there is an oil cooling system with a circulating gear pump entirely independent of the lubricating system. The oil in the sump is taken by this separate gear pump and passed through cooling coils exposed to the air stream from the propeller, and then delivered to the propeller driving gears, thence finding its way back into the oil sump.

As would be expected in aeronautical use, light-weight reciprocating parts are a necessity. The connecting rods are of light section and are made of chrome nickel steel machined on all sides. They are eleven and three-eighths inches between centers and the webs and flanges are but five-sixty-fourths of an inch in thickness. A complete assembly of piston, piston pin, connecting rod

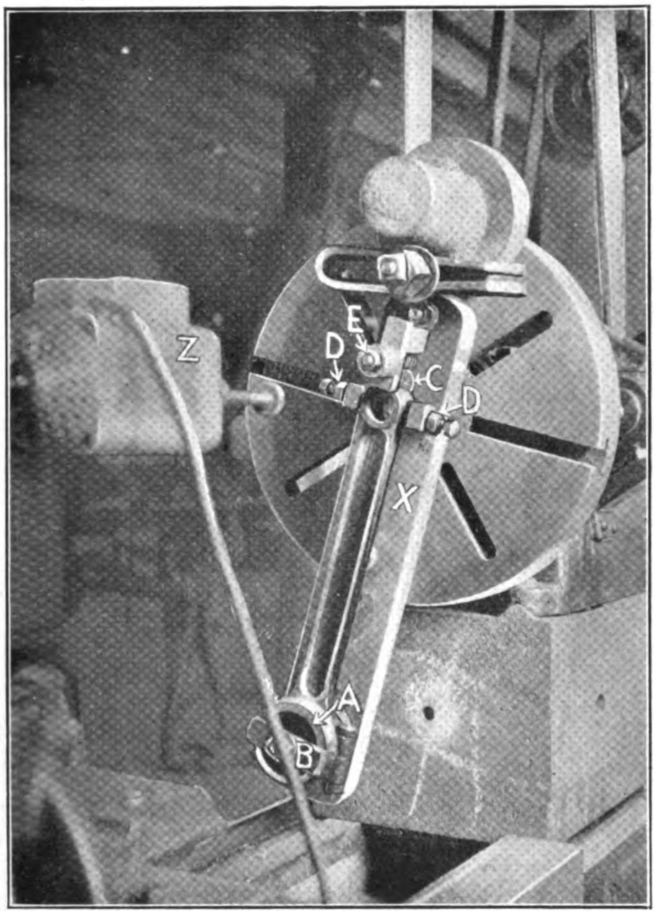


(Published by permission of American Machinist)

FIG. 3. Grinding piston pin hole

and connecting rod cap weighs but three and three-quarters pounds. The babbitt is applied directly to the steel at the lower end of the connecting rod. To show the accuracy necessary in the various machining operations of aeronautical motors in general, and the Thomas motor in particular, we are able to print two views, Figures 1 and 2, showing the method used to insure that the two bearings at the ends of the connecting rod are perfectly parallel. Figure 3 shows the rod placed on a special fixture bolted to the face plate of a lathe for grinding the piston pin holes by means of an electrically driven grinder shown in position at Z. Figure 4 shows the connecting rod position in a special boring fixture. An extended piston pin is placed in position for locating the small end of the rod in this fixture. The three studs shown at D are brought into contact with the lower side of the rod end by means of the shoulders E. After these have been moved into contact with the rod, they are locked by the screws F. Sidewise adjustment is furnished by means of screws on each side, as at G. This prevents any springing of the rod while clamping. When once set up in this

manner, the big end is ready to be finish-bored, insuring that the big and small ends will be absolutely parallel. Although this is but a single phase of what may seem to be unnecessary accuracy on connecting rod bearings,



(*Published by permission of American Machinist*)

FIG. 4. Finishing Connecting-Rod Bearing

it is felt by the manufacturers to be well worth while, as it results in not only a smoothly running motor, but one which is reliable as well as durable.

The crankshaft is of very generous proportions. It is supported on three main bearings running in a novel type of perforated steel back babbitted bearing. The main journals as well as the crank throws are two and one-quarter inches in diameter. The total length of the three main bearings is eleven and seven-sixteenths inches, which not only furnishes very generous bearing surface, but permits the most rigid assembly.

Running at full power (140 H.P.), these motors consume fourteen gallons of gasoline per hour and one and one-half gallons of oil.

CORNELL FORCES TO MOBILIZE IN NEW YORK CITY

In anticipation of the semi-centennial celebration in 1918, the Cornellian Council is preparing for a mobilization of the Cornell Alumni of New York City and vicinity. The first volley is to be fired at a **monster Cornell supper** at the Waldorf-Astoria on Nov. 20. The speakers at this occasion will be: President Schurman, Chas. M. Schwab, Major-General Leonard Wood, George C. Boldt, V. G. White, and "Dan" Reed. Enlist and join the ranks now!

BRIEF ENGINEERING SURVEY*

SELF-LUBRICATING METAL

A metal or alloy which will combine self-lubricating qualities and strength is one which has long been sought and the *Scientific American* tells of an interesting achievement in this direction.

Graphite possesses wonderful self-lubricating qualities and would make a perfect anti-friction substance in the manufacture of bearings were it not so fragile. An American concern has partially overcome this disadvantage by properly impregnating graphite with metal.

The graphite to be impregnated is first placed in a graphite crucible together with the molten metal. The crucible is then placed in the cylinder of a large press and a partial vacuum created simultaneously with the application of heat. This tends to expel the air from the pores of the solid graphite previous to forcing the metal in. Upon completion of this operation pressure is applied and the molten metal entirely impregnates every pore of the graphite.

The Graphalloy as it is called is suitable for light work, being used extensively for loose pulleys. Oil has a favorable effect on it and where used the Graphalloy gives a factor of safety in preventing sticking or seizing when the oil supply fails. This bearing metal promises to fill a long felt demand for a self-lubricating bearing on light machinery where the use of oil is objectionable or where there is a chance of failure to oil a bearing regularly.

CUTTING WITH THE OXY-ACETYLENE TORCH

The process of cutting metal by the oxy-acetylene flame which is supposed to have been invented by Felix Jotrant, a Belgian, to whom patents were issued in 1907, is limited to cutting steel, wrought iron, and cast steel and is not available for cutting cast iron or any non-ferrous metals. An interesting account of the process is discussed by Henry Cave in *The Engineering Magazine* for September.

Aside from the engineering applications, it is becoming very widely used for many other purposes, such as to save human life, as shown by the cutting of holes in the side of the excursion steamer Eastland in the recent disaster in Chicago.

Some fire departments are equipped with outfits for cutting grates, bars, doors and numerous other obstacles, thereby saving much time in getting at the fire.

At present very accurate work is being done with it in making dies and tools. Tests show that metal such as Jessup's cast steel is not affected as to its carbon content by the process and it is safe to infer that the steel has not been injured. Actual tests of tools cut by this process have proved this to be the case.

*By F. L. Fairbanks, Librarian of Sibley College.

SOME ETHICAL BUSINESS PRINCIPLES

EDITOR'S NOTE:—The following "business-creed" was drawn up by Prof. Vladimir Karapetoff of the Electrical Engineering Department, Sibley College, who dedicated them to the Junior Engineers of the New England Westinghouse Company, when he left the employ of the Company this September. Other organizations might do well to imitate and follow them.

ACCURACY

We believe in accuracy in all our acts, statements, reasoning, workmanship, appointments, promises, drawings; in fact, in everything that is associated with our name.

VERACITY

We believe in veracity towards our associates, superiors, subordinates, clients, competitors, beggars, benefactors, members of our family, and especially towards our own conscience when it is accusing us.

FULFILLING A PROMISE

We believe that fulfilling one's promises in spite of all obstacles and against one's own advantage is the greatest single asset and virtue in business.

INITIATIVE

We believe in initiative, which in the business world usually means helping everyone around you without being told to do so and without being obnoxious.

KEEPING SUPERIORS POSTED

We believe in keeping our superiors posted on what we are doing so as to simplify their supervision over us. Having finished a task we report at once, or if the job could not be done we notify the head man without delay. We train our boss so that when he does not hear from us he knows that everything is O. K.

SURPRISES SHOULD NOT BE SPRUNG

We believe that no surprises should be sprung on our business associates in the form of an unexpected official act or letter. It is both wise and honorable to discuss a matter with a person informally and to find his attitude towards it before taking a decisive step.

HARMONIZING VIEWS

We believe in harmonizing views whenever possible and in foregoing a distinct name for the sake of friendship with those to whom this name may be offensive.

CO-OPERATION

We believe that a lasting monument is usually a result of wise and unselfish co-operation wherein everyone works on the part he is best suited for and is so busy and interested in the work that he forgets to hew his name on the stone.

SYSTEM, ORDER AND SELF-DISCIPLINE

We believe in system, order, and self-discipline for the sake of those with whom we are associated. This is but a specific case of the Golden Rule and it works fine. We do not tax our memory beyond reason because an omission or a misstatement may hurt a friend of ours.

BEING OPEN-MINDED

We believe in being open-minded because we remember many a case when we were glad that things did not turn out our way and sorry when they happened the way we wanted them to.

GIVING FULL CREDIT TO OTHERS

We believe in giving full credit to others because real worth cannot be hidden very long, and a professional thief is not a very far-sighted individual.

PERSUASION RATHER THAN COMMAND

We believe in persuasion rather than command for the same reason for which we prefer an electrically started automobile. Incidentally, the most efficient organizations are those in which the men understand what they are doing and believe in the method of procedure.

MOBILIZING RESOURCES

We believe in mobilizing the resources of our organization when an important problem arises. We see to it that those whose skill or knowledge exceeds ours are drawn into the discussion and not kept out for a selfish reason.

EDITORIAL

(Continued from page 28)

men, crew men, and so on thru all the branches, find themselves the next year competing for and winning honors in major sports.

In each of the intercollege sports crew, cross-country, baseball, basketball, track and gridiron as well as in the indoor meet permanent trophies are given to the winning team. Let us hang about seven of these up in our library this year.

Professor C. A. Pierce has been appointed the Sibley representative on the Intercollege Athletic Association board and we can look toward him for enthusiastic support and coöperation in all of our activities. Captains are to be selected for the various teams and bear in mind that a captain no matter how good he may be can not win a crew race or a track meet alone.

Gridiron is the first of the sports to be started and now there are fifteen men trying out for the team. This is a start but why let it go at that, get under and lift!

Previously, dues of fifty cents a term were charged to cover the expenses of equipping the teams. Last year a new plan was adopted. A tag day was inaugurated and tags were sold at twenty-five cents each whereby more money was raised and each man paid less than before. The same plan will probably be followed this year. EVERY MAN IN SIBLEY COLLEGE IS A MEMBER OF THE SIBLEY COLLEGE ATHLETIC ASSOCIATION.

G. AUSTIN WORN.

PERSONALS

Erwin W. Thompson, '81, a member of the A. S. M. E., is the American Commercial Attaché, American Legation, The Hague, Holland. During the war any mail for him should be addressed to the Commerce Dept., Washington, D. C.

H. E. Longwell, '83, is general manager of the Westinghouse Air Spring Company, Smalley Bldg., No. 3, New Haven, Conn. He is a member of the A. S. M. E. and the S. A. E.

Bryant Harmon, '89, is employed by the Celluloid Company of 290 Ferry Street, Newark, N. J., as Works Superintendent. He is a member of the Engineer's Club and the Machinery Club, both of New York.

John W. Kirkland, '89, is vice-president of the South African General Electric Company of Johannesburg, Transvaal, and is a member of numerous engineering societies, among them the A. I. E. E. He may be addressed at P. O. Box 1905, Johannesburg.

Capt. Frank A. Barton, '91, was promoted to the rank of major on June 4. He expects to return to the United States from service in the Philippines in April, 1917. From 1904 to 1908 Major Barton was professor of military science and tactics in Cornell University.

H. A. Benedict, '91, is acting in the capacity of mechanical engineer for the Public Service Railroad Company of Newark, N. J. He lives at 23 Glenwood Ave., East Orange, N. J.

L. C. Jackson, '91, designs pleasure cars for the Pierce-Arrow Motor Car Company, Buffalo, N. Y. His home and mail address is 351 Hoyt St., Buffalo, N. Y. He is a member of the A. S. M. E. and the Engrg. Soc. of Buffalo.

William H. Bœhm, '93, has recently been appointed vice-president of the Fidelity & Casualty Company, 92 Liberty Street, New York. He still retains the superintendency of the steam boiler and fly wheel insurance divisions of that company, with which he has been identified for some years.

Edward S. Cole, '94, who specializes in hydraulic engineering, is the president of the Pitometer Company, 25 Elm Street, New York. He is a member of the following societies: A. S. M. E., A. S. C. E., Am. Water Works Assoc., New Eng. Water Works Assoc.

Walter E. Dunham, '95, is Supervisor of Motive Power & Machinery for the Chicago & Northwestern Railway, Winona, Wis.

H. H. Alcock, '96, is associated with several Cornell men as a director of the Inter Ocean Steel Products Corporation, 165 Broadway, New York. This company controls the M. F. P. aeroplane and a self-propelled car for steam railroad service, and is handling screw machine work which is made up to a large extent of spark-plug parts.

Charles E. Rogers, '96, general manager, Fraser & Chalmers, Ltd., 3 London Wall Bldgs., London, England, resides at the "Manor House," Erith Kent, Eng.

Charles M. Howe, '97, was recently appointed by Governor Dunne to be engineer-in-chief of the Illinois Naval Reserve, with the rank of lieutenant-commander. His home address is 2222 Lincoln Street, Evanston, Ill.

John J. Swan, '97, is a member of the American Arms Corporation, 111 Broadway, New York City.

Clarence E. Breckenridge, '00, of 17 Fairview Ave., Madison, N. Y., is assistant Chief Engineer of the Aetna Explosives Company, Inc., 2 Rector St., New York City. He belongs to the A. S. M. E. and the American Electrochemical Society.

G. Stuart Laing, '01, is acting in the capacity of assistant manager, in Chile, of the West India Oil Co. His mail may be sent to Casilla 899, Valparaiso, Chile. He is an associate member of the A. S. E. E.

H. E. Johnston, '02, is in the manufacturing line. He is with the Cohoes Iron Foundry & Machine Co., Cohoes, N. Y. His mail should be sent to his home address, 546 Third Ave., North Troy, N. Y.

R. C. Fenner, '03, is the treasurer of The George Zucker Co., makers of Acme white finish, rouge and compositions for all industries, 202–208 Emmett Street, Newark, N. J.

W. H. Aldrich, '04, is superintendent of power house, Cleveland Electric Illuminating Company, Cleveland, Ohio.

Samuel A. Middaugh, '04, is with the U. S. Army Engineer Dept., P. O. Box 349 (Room 407 Federal Bldg.), Cleveland, Ohio. His home address is No. 1567 Orchard Grove Ave., Lakewood, Ohio.

Albert D. Brinkerhoff, '05, holds the position of Electrical and Purchasing Engineer for the Southern Traction Company of Dallas, Texas. He is a member of the A. I. E. E.

Frederick Leighton, '05, is an instructor in Physics in Germantown High School, Philadelphia, Pa. He may be addressed as follows: R. F. D. No. 3, Newton Square, Pa.

Bernhard E. Fernow, '06, is shop superintendent of the Cutler Hammer Clutch Company, Milwaukee, Wisc. He is an associate member of the A. I. E. E.

J. E. Forgy, '06, assistant purchasing agent of The Locomobile Co. of America, is now living at 1910 Park Avenue, Bridgeport, Conn.

W. H. Balcke, '07, is employed by the Stone & Webster Engineering Corporation of 147 Milk St., Boston, Mass., in their engineering department. He lives at 12 Wilson St., Winchester, Mass.

Fred S. Sly, '07, who is with *The American Architect,* was instrumental in bringing about a change whereby that publication assumed control of the *Metal Worker* and the *Building Age*. The offices are located at Fourth Avenue and Seventeenth Street, New York City.

A. L. Frost, '09, is now Superintendent of Traffic Department of the Winchester Repeating Arms Co., New Haven, Conn.

Alexander W. Hamilton, '09, is in Petrograd, as technical representative of the American Locomotive Company. His address is Nevsky, Prospect 1, Petrograd, Russia.

Thomas H. S. Andrews, '10, is secretary of the Andrews Construction Corporation, 120 Liberty Street, New York City. He is living at 367 Grand Ave., Brooklyn, N. Y.

H. C. Boos, '10, is in business as a consulting engineer and patent solicitor, with offices in Suite 2423–4, 13–21 Park Row, New York City.

H. L. Slauson, jr., '10, fills the position of Electrical Controller Engineer with the Westinghouse Electric & Manufacturing Company of East Pittsburgh. He may be addressed at 506 Kelley Ave., Wilkinsburg, Pa., where he resides. He is a member of the A. I. E. E.

Clifford Augustus Brant, '11, is with the Toms River Electric Company, 7 Washington St., Toms River, N. J. He is a member of the A. I. E. E. and the A. E. R. A.

John M. Grant, '11, now on duty in France, is captain of the First Divisional Signal Company, First Australian Division.

Martin Janowitz, '11, is chief draftsman and assistant engineer for the J. P. Devine Company, 1372 Clinton St., Buffalo, N. Y. His mail should be sent to his home address, 387 Jefferson St., Buffalo,

Henry P. Reid, '11, is teaching in Prince Royal's College, Chiengmai, Siam.

A. C. Towers, '11, is in business as an electrical engineer in Uruguay. He is residing at Sunnyside, 27 Calle Ellaun, Montevideo, Uruguay, and is a member of the I. E. E. (England) and the A. I. E. E.

John Winslow, '11, is on the Engineering Staff of the Winchester Repeating Arms Co., New Haven, Conn.

Edward R. Fickenscher, '12, is one of the members of the Union Oil Company, Front and Fayette Streets, Baltimore, Md. He lives at 2744 St. Paul Street.

Karl W. Gass, '12, is employed by Chester & Fleming, Consulting Engineers, as an engineer. His place of business is 1111 Union Bank Bldg., Pittsburgh, Pa., and his home address, 125 Stratford Ave.

H. B. Joyce, '12, who was until recently with The New York Ediosn Co., has accepted a position as power engineer with The United Electric Light & Power Co., 130 East Fifteenth St., New York.

J. P. Leinroth, '12, has changed his address from Philadelphia, Pa., to 290 Seymour Ave., Newark, N. J.

Charles D. Maxfield, '12, was married to Miss Florence E. Taylor, a sister of Mr. J. F. Taylor, of Oneida, on August 9, 1916, at Union Chapel, South Schroon, N. Y. They will live in Bridgeport, Conn., where Maxfield holds a position in the engineering department of the Bryant Electric Company.

William E. Munk, '12, is a partner in the Electric Controller Company of Indianapolis.

J. W. Stoddard, '12, is with the Boston Virginia Transportation Company, 27 William Street, New York City.

David Younglove, '12, was married to Miss Jean Clift, daughter of Mrs. Eliza Hunter Clift, at Syracuse, N. Y., on September 5, 1916. They will be at home after December 1st at 270 Cortland Ave., Syracuse.

Richard A. Dittmar, '13, was married to Miss Mary Helen Lyford, daughter of Mr. and Mrs. Victor G. Lyford, on October 14th, 1916, at Falls City, Nebraska. At home after December 1st at 113 North Maple Avenue, Hannibal, Missouri.

W. C. Hamilton, '13, is a civil engineer with the Highway Commission, 433 S. Salina St., Syracuse, N. Y. He is living at Weedsport, N. Y.

Ching Fei Hou, '13, has returned to his home country and is now workshop manager of the Kalgan Workshop, Kalgan, China.

George R. Rinke, '13, has been transferred back to the Eastern Power & Light Corporation, and is now chief engineer for the West Virginia Traction and Electric Company which operates Central Station, Traction, Gas and Water Works in Wheeling and Morgantown.

George H. Rockwell, '13, who was formerly with the Liquid Carbonic Company, has left that firm to accept a position as superintendent with the Cambridge Rubber Company. His new address is 748 Main Street, Cambridge, Mass.

Frederick Stillman Rogers, '13, an instructor in Sibley College, married Miss Edna Collins Reid, daughter of Mr. and Mrs. J. G. Collins, of Ithaca, on September 14th.

H. G. Weidenthal, '13, is in charge of the steel plant of the John A. Crowley Co., of Detroit, Mich.

W. B. Baker, '15, is an engineer with the International Paper Company, Glens Falls, N. Y., in the Bureau of Tests.

Everett R. Morse, '15, was married to Miss Kathryn A. Strauss of Ithaca on the evening of the 16th of October. Mr. and Mrs. Morse left after the ceremony for a several weeks' automobile trip to Syracuse and the Adirondacks. They will be at home after November first at 301 West State Street, Ithaca, N. Y. Mr. Morse is affiliated with the well-known Morse Chain Works, Ithaca, N. Y., makers of the largest silent chains, based on an entirely new link.

Walter P. Read, '15, is chief engineer of the Beaver Manufacturing Company, makers of gasoline motors, Milwaukee, Wisconsin.

R. A. Anderson, '16, is with the Westinghouse Company. His address is 608 South Linden Avenue, Pittsburgh, Pa.

George F. Bason, '16, was married to Miss Mary Isabel Reuther, daughter of Mrs. Edward Johnston, at

Arlington, N. J., on September 18. Mr. and Mrs. Bason will reside at 1101 North Tioga Street, Ithaca, N. Y.

Harry B. Bois, '16, of 152 East 155th Street, Harvey, Ill., is with the Whiting Foundry Equipment Company.

Harland B. Cushman, '16, is engaged in research work for the German-American Button Company, of Rochester, N. Y. His address is 609 Y. M. C. A. Building, Rochester.

Julian Harvey, '16, is now working for the United Piece Dye Works, of Lodi, N. J. Address: 312 Henry St., Hasbrouck Hts., N. J.

D. F. Potter, '16, captain of last year's varsity cross country team, is taking a special course with the General Electric Company in Schenectady, N. Y. We learn that he has also been assisting in the coaching of the Schenectady High School track team.

W. T. Todd, jr., '16, is in the sales department of Somers, Fitler & Todd. His address is 2783 Beechwood Boulevard, Pittsburgh, Pa.

C. W. Roof, '17, who left the university last winter on account of illness, has returned to resume his work in Sibley College this term.

OBITUARY

Judson H. Boughton, '03

Judson Hartwell Boughton, M.E., '03, died July 29 at Milwaukee, Wis., from the effects of burns received in the explosion of a motor boat engine on Lake Michigan, July 27. Boughton was president of the Great Lakes Boat Building Corporation of Milwaukee and he was testing one the company's new boats when the accident occurred. He was accompanied on the boat by his niece, Miss Annette Housam, who leaped overboard to escape the flames and was drowned. Boughton was thirty-five years old. After studying at Purdue University he entered Sibley College in 1902 and graduated in 1903. For several years after his graduation he was employed in the New York office of the became the managing director, and he moved from St. Louis to Milwaukee last February. He leaves a wife and two children.

Harold Coleman Blackburn, '16

Harold Coleman Blackburn, '16, died of typhoid fever in Hartford, N. J., on Oct. 26, 1916. He was born on the same month and day, 1887. His record at Cornell was very good. He was a member of the A. S. M. E., A. I. E. E., Sibley Association, and an Instructor in the Department of Physics.

BOOK REVIEWS

Hydraulics. By R. L. Daugherty, A.B., M.E., Assistant Professor of Hydraulics at Rensselaer Polytechnic Institute, formerly Assistant Professor of Hydraulics, Sibley College, Cornell University. 267 pages with illustrations. 1916. McGraw-Hill Book Co., New York. Price $2.50.

This book was prepared primarily as a text for students who are required to cover the wide field of hydraulics in a limited time. Because of the short time alloted to that subject in Sibley College Professor Daugherty has had an excellent opportunity of determining in just what manner the subject ought to be presented.

For some years his classes used mimeographed sheets of explanations and problems along with one of the standard text books on hydraulics. These were supplemented with an occasional illustrated lecture. His new text book in general includes a more thorough treatment of the substance formerly embodied in these three sources, compiled in a brief and concise manner.

One of the characteristics of the book is that general cases are treated and only basic principles set forth. For example the solutions of all problems involving the flow of water is made to depend upon the applications of Bernoulli's theorem, which is the key to the rational treatment of the subject.

The large number of photographs and diagrams serve to simplify the explanation and impress more firmly the point under consideration. This is particularly true of the section dealing with turbines and centrifugal pumps where only the very basic formulæ and equations are given.

No attempt is made to treat of the design of turbines or pumps but with the theory given the nature of characteristics of such machines can be accounted for. This will enable one to compare one type of machine with another and make an intelligent selection for specified conditions.

The subject of the text is treated under the following heads: Introduction, Intensity of Pressure, Hydrostatic Pressure on Areas, Applications of Hydrostatics, Hydrokinetics, Applications of Hydrokinetics, Flow through Pipes, Uniform Flow in Open Channels, Hydrodynamics, Description of the Impulse Wheel, Description of the Reaction Turbine, Water Power Plants, Theory of the Impulse Wheel, Theory of the Reaction Turbine, Turbine Laws and Factors, The Centrifugal Pump, and Appendix.

Homan's Automobile Handbook. The Gasoline Motor Car. By J. E. Homans. 248 pages illustrated. 1916. Sully & Kleinteich. 373 Fourth Ave., New York. Price $1.00.

This book while written in a popular style covers the ground of motor car construction with much satis-

faction. It deals with the most common types of cars and gives good popular descriptions of the various parts, their construction, use and operation. It is a book from which any automobile owner or operator might derive much information, whether he be a trained engineer or a youth in his teens.

The book covers the following subjects: The Motor Car Briefly Described, The Transmission Apparatus of a Motor Car, Planetary Speed-Changers, "Clash" Gear Speed-Changers, The Friction Drive, The Magnetic Transmission, The Motor Car Engine, Engine Elements and Adjustments, The Operation of the Motor-Car Engine, Power Estimates for Motor Car Engines, Multiple-Cylinder Gasoline Engines, Cylinder Cooling Devices, Vaporizing and Mixing the Engine Fuel, The Ignition Apparatus Described, The Lubrication of Moving Parts, The Operation of a Motor Car and Engine, Adjusting and Ignition, Adjusting the Mixture, Causes and Symptoms of Engine Troubles.

Examples in Alternating Current. Vol. 1. By Prof. F. E. Austin, Hanover, N. H.; 223 pages, 4½ x 7½ with illustrations and tables. Price $2.40. Published by the author.

The second edition of this handy book has just appeared. With the exception of a few additions the book is practically the same as the first edition. It is a condensed but concise book containing many examples and problems covering well the field of alternating current. Since the appearance of the first edition the book has proved itself to be of much aid to the practicing engineer as well as the student engineer. For one working in problems envolving alternating current the tables are most valuable.

Homans' First Principles of Electricity. By J. E. Homans. 248 pages, illustrated. Published by Sully and Kleinteich, New York, 1916. Price $1.00.

In this volume the author has cleverly treated the subject of elementary electricity in a semi-technical manner. The book is written in a clear manner and the style is characteristic of all of Mr. Homans' books. The book should appeal to men interested in electrical work but who have not had the advantages of a university training in physics and engineering. It might, however, be of use to the practicing engineer whose early studies in electricity were not complete or who has not a clear conception of what constitutes the fundamentals of electrical engineering.

A reprint of Professor Karapetoff's article on "Divergence and Curl in a Vector Field in Terms of Curvature and Tortuosity" which appeared in the *Philosophical Magazine* for June, 1916, has just been gotten out in pamphlet form. Those who are interested in the subject should communicate with Professor Vladimir Karapetoff, Sibley College, Cornell University, Ithaca, N. Y.

The Bureau of Standards, Washington, D. C., has just issued several new publications. A brief description of them follows. Those interested in these subjects may obtain copies free by addressing the Bureau of Standards.

"Volume Effect in the Silver Voltameter." (Scientific Paper No. 283).

This paper is a continuation of the Bureau's researches on the Silver Voltameter which is the primary standard for the measurement of the International Ampere. It has been found that when the electrolyte for the voltameter is not sufficiently pure that the deposits in the large voltameters are in excess of those in the small voltameters in series with them. This phenomenon has been called the "volume effect." The present paper shows that this effect is due to the impurities of the electrolyte and not to other causes as was thought by several previous observers. It is also shown that the effect is the same in all forms of the silver voltameter which the Bureau has tested. A theory to account for the effect is given. This phenomenon affords a valuable criterion of the purity of the electrolyte used in the voltameter.

"Properties of Some European Plastic Fire Clays" (Technologic Paper No. 79).

In this is given the properties of five well-known European plastic fire clays used in the manufacture of glass refractories, graphite crucibles, etc. The content of shrinkage and pore water, the drying shrinkage, fineness of grain, mechanical strength in the dried state, the Atterberg plasticity number, rate of vitrification, and softening temperature have been determined. A comparison is made of these material as to their suitability for several purposes, and tentative specifications are suggested for the selection of clays which might be used as substitutes for these foreign materials. American clays are available which, if used as mixtures, can take the place of the imported ones with equally as good or superior results.

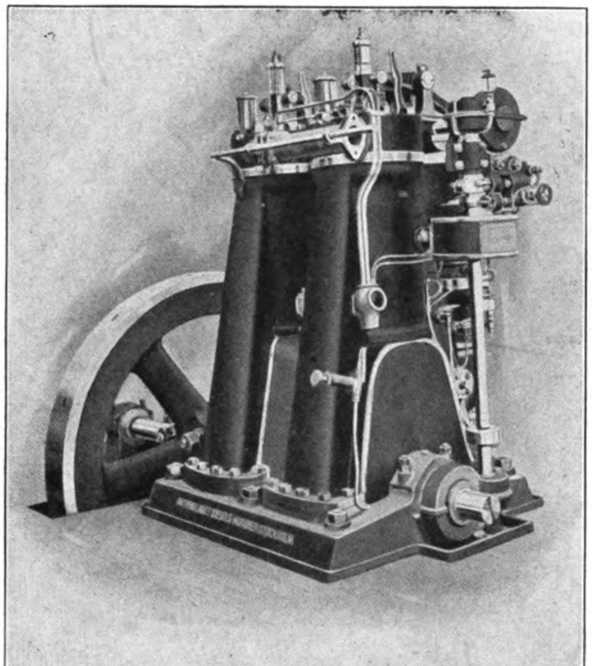
"Constants of Spectral Radiation of a Uniformly Heated Inclosure or So-Called Black Body, II" (Scientific Paper No. 284). The analysis of energy from a uniformly heated inclosure involves the determination of the amount of energy at various wave lengths in the spectrum. This may be plotted as a curve in which the ordinates (heights) represent energy and the abscissas (the horizontal scale) represent the wave lengths. Such a curve shows the energy distribution for a given temperature. The form of the energy curve does not depend upon the materials which constitute a heated inclosure; but it is a function of the temperature. Such an inclosure may therefore be called an "ideal radiator." The elements of this curve may be computed from two numerical constants which must be accurately known. The present paper gives a precise re-computation of these two "constants."

"A Study of the Inductance of Four-Terminal Resistance Standards" (Scientific Paper No. 281). This paper deals with the inductance of electrical

(*Continued on page 54*)

UNIVERSITY NOTES

During the summer the Diesel Engine shown in the cut and an Ice Machine have been installed in the Mechanical Laboratory of Sibley College.



DIESEL-POLAR-MOTOR TYP T2G.

The Diesel Engine was bought from McIntosh & Seymour Corporation, Auburn, N. Y. It was sent from Sweden and served the Company as a model after which to pattern other engines. As the cut shows it is a standard two-cylinder T type and is arranged for direct connection to a 25 K. W. D. C. generator.

At the altitude of sea level at 310 R. P. M. this engine has a continuous load capacity of 45 B. H. P. with a momentary overload capacity of 20%.

The consumption of fuel at sea level based on a heating value of not less than 18,500 effective B. T. U. per pound is as follows:

Full load	.441	lb.	per	brake	horse	power	per	hour.
¾	" .452	"	"	"	"	"	"	"
½	" .485	"	"	"	"	"	"	"
¼	" .727	"	"	"	"	"	"	"

These rates are subject to a tolerance of not over 5% and a correction for any deficiency in thermal value of fuel.

Approximate weight, 15,725 lbs.

The Ice Machine is a two-ton York Ammonia Absorption Machine with brine cooler and brine circulating system.

Both machines will be ready for use next term.

A new Moving Picture Machine enclosed in an all-steel booth with modern ventilation is now located in the balcony of Sibley Dome. It is a Powers' Six-A hand-driven machine, 1917 model. Upon investigation it was ascertained that numerous educational slides of engineering nature were available and could be obtained gratis from engineering concerns. The committee in charge has about forty films such as Mfr. of a Ford Automobile, Mfr. of Silk, Paper Industry, Lumber Industry, From the Ore to the National Tube Pipe, etc.; also Welfare, Safety First, and Industrial Films. These will be shown on various occasions during the coming term. Admission will be free. Mr.. G. N. Best, '18, is the operator.

THE PRESIDENT'S ANNUAL ADDRESS

President Schurman delivered his annual address of welcome to the students of Cornell University on October twelfth, all classes being suspended at twelve o'clock so that everyone might hear it. This year Schœlkopf Stadium was the scene of the event, as the past two years have proven that Bailey Hall is too small for the purpose. In his speech, which was one of general interest to the students, President Schurman discussed, among other things, the various phases of college life, physical development, military training, athletics and the like. He gave the following figures with regard to registration this year as compared with that of last: total registration at the opening of the university 4,746, of which 3,310 were old students and 1,436, new. The corresponding figures for last year were 4,623; 3,123; and 1,500, respectively. This is indicative of a total registration for the year that will probably exceed last year's record of 5,656.

THE CADET CORPS

In his report on the Cornell University Cadet Corps this year, Capt. Schindel, who has inspected the corps for the past three years, makes mention of the fact that the military spirit here is developed "to an extent not otherwise to be found in colleges of this size." He notes that the duties of the cadets are performed with the highest zeal, and that the team-work in the companies and battalions is excellent. He says the field work on inspection day showed considerable improvement in the tactical instruction of officers and non-commissioned officers. "The great stimulation of interest among all persons at the University is most marked, and the prospects for a brilliant future for the work of the cadet corps are assured."

For the past three years, Cornell University has been ranked among the ten leading military institutions of the country, and as a reward, the corps has been supplied with the new Springfield rifles.

THE ARMORY

For various reasons the work on the new armory, which is said to be the largest in the State, has not been progressing very rapidly. Among the draw-backs were unfavorable weather conditions and labor shortage.

It is gradually nearing completion, however. The outside is practically finished, except for one tower, but there is still some inside work to be done,—finishing the walls, laying of the floor, etc. It is expected that the hall will be ready by early spring for the use of the corps, which will be twice as large as that of last year, since both sophomores and freshmen must now drill.

SOCIETY NOTES

A new society, "The Optical Society of America" has sprung into existence. It will study the application of optics to manufacturing, and further the cause of pure and applied optics. A semi-monthly *Journal of the Optical Society* will publish its proceedings and papers. The society and journal will be of interest to the engineer in so far as they will take up articles pertaining to Illuminating Engineering and Radiation Pyrometry.

BOOK REVIEWS

(*Continued from page 52*)

resistance of less than one ohm. New methods of measuring alternate current require small resistances in the laboratory tests. Even very small errors in a standard would introduce serious errors in resulting measurements. This represents an important and practical contribution to precision measurements.

"The Determination of Aluminum as Oxide" (Scientific Paper No. 286). This paper gives the results of a research to define the conditions for the determination of aluminum. From observations made with a hydrogen electrode and with suitable indicators, the conditions for the quantitative precipitation of aluminum hydroxide by ammonium hydroxide were determined. In practice the completion of precipitation may be defined by means of methyl red or of rosolic acid. The effect of various factors upon the precipitation, washing and ignition of the precipitate was determined. The procedure for obtaining accurate results is also described.

New Publications, Department of the Interior, Bureau of Mines

Bulletins

Bulletin 105. Black damp in mines, by G. A. Burrell, I. W. Robertson, and G. G. Oberfell. 1916. 92 pp.

Bulletin 116. Methods of sampling delivered coal, and specifications for the purchase of coal for the Government, by G. S. Pope. 1916. 64 pp., 5 pls., 2 figs.

Technical Papers

Technical Paper 102. Health conservation at steel mills, by J. A. Watkins. 1916. 36 pp.

Technical Paper 151. Coke-oven accidents in the United States during the calendar year 1915, compiled by A. H. Fay. 1916. 18 pp.

EMPLOYMENT NOTES

239. Castle Kid Co., Engineering Dept., 1516 Broadway, Camden, N. J., wants young man to study methods of improving production and equipment. Permanent and well paid position for the proper man.

240. Mr. Oscar B. Bjorge, Chief Engineer, Clyde Iron Works, Duluth, Minn., wants draftsman of two or three years' experience. Prefers personal interview before engaging men. (Logging, hoisting and excavating machinery.)

241. Mr. G. G. Robbins, Chief Draftsman, Shepard Electric Crane and Hoist Co., Montour Falls, N. Y., wants experienced jig draftsman.

242.* A concern in Massachusetts wants man capable of handling electric lighting layouts of buildings, particularly industrial buildings.

243.* A Chicago engineering concern wants engineering draftsman to start at $75 with opportunity for all around development.

244. U. S. Civil Service Exam. No. 1413, Nov. 13 for Expert Electrical and Mechanical Aid, $12.48 per diem, in Bureau of Yards and Docks, Navy Dept. Write to Civil Service Commission, Washington, D. C., for Form 1312.

245. Mr. C. R. Johnson, Chief Chemist, Goodyear Tire and Rubber Co., Akron, O., wants recent graduates in the Experimental Department on development work, construction, efficiency work, etc.

246. Prof. G. A. Covell, Oregon Agricultural College, Corvallis, Oregon, wants Assistant Professor to teach Thermodynamics, Heat Power, and possibly, some mechanics.

247. A. Wood, '91, general manager of Niles Tool Works Company, Hamilton, Ohio, has openings for a few men who have had experience in heavy machine tool designing.

248. Professor E. A. Fessenden, Pennsylvania State College, wants:

(1) Experienced instructor or Assistant Professor for steam-engineering, power plant design, heating and ventilation and possibly mechanical laboratory.

(2) Instructor or assistant for elementary machine design, kinematics, and possibly laboratory.

249. Mr. I. Mayer, general sales manager, Hohmann & Maurer Mfg. Co., Rochester, N. Y., wants road salesman for Industrial Thermometer Department. Man should have had some experience.

250. Mr. Harold Riegelman, care Olcott, Gruber, Bonynge & McManus, 170 Broadway, New York, knows of an excellent opening for a factory manager familiar with manufacturing such articles as typewriters, sewing machines, etc., in large quantities. Good salary for able man.

*Address applications to this number, care of Sibley Employment Bureau, for forwarding.

(*Continued on page 9 advertising section*)

BOOK REVIEWS

(Continued from page 54)

Technical Paper 159. Production of explosives in the United States during the calendar year 1915, with notes on coal-mine accidents due to explosives, and list of permissible explosives, lamps, and motors tested prior to June 1, 1916, compiled by A. H. Fay. 1916. 24 pp.

Technical Paper 161. Construction and operation of a single-tube cracking furnace for making gasoline, by C. P. Bowie. 1916. 16 pp., 10 pls.

NOTE:—Only a limited supply of these publications is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

The Bureau of Standards announces a new publication entitled "Electric Units and Standards." This publication gives comprehensive and up-to-date information regarding the units and standards in terms of which electric and magnetic measurements are made. It includes the history of the units and the evolution of the definitions upon which the laws on electrical standards are based. The laws of this and other countries are given. These laws are in substantial agreement, and the various national bureaus of stand-

ards coöperate in maintaining the fundamental standards. The circular gives conversion factors, by means of which measurements may be expressed in any desired unit. The information on electric units and standards had not previously been available in a single publication. This paper is now ready for distribution and those interested in the subject may obtain a copy free by addressing a request to the Bureau of Standards, Washington, D. C.

Bureau of Standards (Scientific Paper No. 290) entitled "A Variable Self and Mutual Inductor."

This paper outlines the development of a new form of instrument for varying the self inductance of a circuit, or the mutual inductances between two circuits. It consists of two pairs of fixed coils held in stationary hard rubber disks between which a third disk carrying two coils is arranged to be rotated. The form and the spacing of the coils were determined so as to secure the following advantages: (1) high ratio of inductance to resistance; (2) scale divisions of uniform length reading directly in units of inductance; (3) a static arrangement of the coils, which reduces the liability of errors caused by the proximity of other instruments or of conductors carrying currents. Diagrams and data are given from which instruments of this type can be designed for given uses. Comparison is made of the new instrument and of some other older forms of variable inductor, including the Ayrton-Perry.

This paper is now ready for distribution. Those interested in the subject may obtain a copy free by addressing a request to this Bureau.

PERSONALS

(Continued from page 51)

A group of four Cornell men are living together in Chicago with a Harvard man, a Pennsylvania man, and a Chicago man. The Cornell men are: F. H. Philbrick, M.E. '07; R. H. Coit, Arch. '07; D. M. Dewey, M.E. '14 and H. H. Allport, M.E. '14. Mr. Philbrick is manager of the Midvale Steel Company; Mr. Coit is in the Bond Department of the Peoples' Trust and Savings Bank; Mr. Dewey is factory engineer for the Stromberg Motor Device, and Mr. Allport is at present instructor in Fire Protection Engineering at Armour Institute and assistant engineer for the Underwriters' Laboratories in Chicago.

With the Underwriters' Laboratories in Chicago there are six Cornell men as follows: W. C. Robinson, Sibley '89, chief engineer; W. G. Howell, Sibley, '89; H. B. Freeman, ex. Sibley, '09; W. H. Chapman, M.E., '13; F. H. Lockwood, M.E. '13, and H. A. Allport, M.E. '14.

EMPLOYMENT NOTES

Continued from page 54

266. Mr. R. E. Hopkins, '12, of the Ingersoll-Rand Co., Painted Post, N. Y., wants recent graduates for production work, engineering, inspection and sales.

Continued on page 14 adv. section

EMPLOYMENT NOTES

(*Continued from page 9 adv. section*)

251. (a) A steel company having 28 plants wants man who has had some experience in sanitary and welfare work to inspect plants and take up with the managers the conditions found. Man must have ability and tact.

(b) They want also a man for steam engineering work—should have had one or two years' experience in this line.

Address applications to No. 251 Sibley Employment Bureau for forwarding.

252. A large manufacturing concern in Cleveland wants a high grade assistant to the Mechanical Engineer to look after the operation and maintenance of mechanical equipment which is of great variety. Must know how to repair, rebuild and redesign properly and quickly. Also to have charge of machine shop. Should have had not less than eight years' experience in this class of work. Good salary. Address applications to No. 252 Sibley Employment Bureau for forwarding.

253. The Savage Arms Company, Utica, N. Y., is desirous of employing several M.E. graduates for general efficiency work. Address H. F. Hodgkins, '15, care of the Company.

254. New York State Civil Service Exams.: No. 218, Junior Assistant, Engineering Departments $901–1200. No. 219 Junior Electrical Engineer, Public Service Commission, first district, $901–1200. To inspect power-houses, subway equipment, etc. Application blanks will not be sent after November 20.

255. Mr. J. C. Parker, Pennsylvania Bldg., Philadelphia, Pa., wants young man to compile engineering cost data for "Lefax" data sheets. Also wants a man familiar with Economics to assist in editorial work.

256. U. S. Civil Service Exams., November 21. No. 1478, Assistant Petroleum Engineer, $1800–2500; No. 1481, Expert Aeronautical Aid, $13 per diem; No. 1506, Designing Mechanical Engineer, $2100 Board of Engineers, U. S. Army, etc.) Write to the Civil Service Commission for form 2118.

257. Mr. O. C. Tutwiler, Vice-President and Manager of Coopers Creek Chemical Company, Real Estate Trust Bldg., Philadelphia, Pa., wants a recent graduate as engineer in a gas works near New York City. "Good opening for man of right type."

258. Mr. A. T. King, care J. B. King & Company, New Brighton, N. Y., wants recent graduate to work up in the business (cement and plaster mills; several works, mines, etc.). Drafting, general engineering and cost accounting.

259. The office manager of a rubber company in Akron, Ohio, wants man between 28 and 36 years of age, of pleasing personality and affability, but with sufficient force to handle situations rapidly and tactfully. Executive ability and understanding of human nature is important as he is to deal with men occupying important positions in order to straighten out annoying and irritating situations. Address applications to No. 259, Sibley Employment Bureau, for forwarding.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI DECEMBER, 1916 No. 3

Published by
THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.
Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year
Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR DECEMBER, 1916

The Sibley Library

In order to encourage the more active patronage of the library it seems to be advisable to emphasize the advantages to be gained by using it and to suggest methods of spending one's time in it to the best advantage. Many upperclassmen seem to appreciate the opportunities the library offers and they will therefore welcome any suggestions which may increase their efficiency in looking up articles. Unfortunately, however, underclassmen are rarely represented among the readers, although there is much that would interest them.

In the four-year course there is time to cover only the more fundamental branches of science and engineering. Greater breadth of education must be obtained through good reading. The Sibley Library offers excellent facilities for acquiring knowledge in numerous supplementary fields as well as for collateral reading in connection with the regular courses. After leaving the university few will be so fortunately located as to have access to similar libraries, and many will regret not having made better use of their opportunities while at college. Spare moments between classes, after luncheon, and in regular study periods can be spent very profitably in the library.

While the books constitute the main portion of the library, the collection of current periodicals forms an equally valuable part. Engineering is developing so rapidly that quite often a text or reference book begins to be out of date in a very short time after its publication. To keep abreast of the more recent developments one must regularly consult the periodical literature. There are certain journals of a general character that all should read. In addition each student should be familiar with the better periodicals relating to the fields in which he intends to specialize. Besides this, the monthly proceedings and annual transactions of the engineering and scientific societies as well as the bulletins of the governmental, state and other engineering bureaus contain much of the most valuable information.

Engineering has become so broad and each field is developing so rapidly that it is difficult to keep posted in any except one's own particular branch. To relieve this situation many periodicals and society journals now devote sections to abstracts of the more important articles appearing in other papers, while some even publish complete indexes of all such literature. In addition, there are several indexes published annually, and various bibliographical lists on file for reference.

One desiring to look up the literature on some engineering subject would probably find it desirable

to proceed substantially as follows: First consult the so-called "pocket-books," the standard reference books and encyclopedias to obtain the status of the subject up to the time these books were published. Incidentally, it will be found that many of these books give reference to the original sources from which they are compiled. Next, for subsequent development, consult the yearly indexes of periodical literature, the "Science Abstracts" and bibliographies. Finally for the very recent literature refer to the abstracts and periodical indexes given in the current numbers of the journals which make a specialty of such matters.

There is also much to be learned from a study of engineering trade catalogues, a rather complete collection of which is to be found in the Sibley library. In this connection many ideas can be gained from a careful perusal of the advertisements in standard periodicals.

To aid the readers in using the library most efficiently the following lists have been posted in the reading room: Books and periodicals of interest to underclassmen; Periodicals with which all engineers should be familiar; Journals devoted to special fields; Journals giving Abstracts, Digests, and Indexes of all current articles; Special bibliographies in various subjects; and other similar lists.

Readers should feel free to consult the Librarian when in need of assistance. It should be remembered however, that engineering covers such a broad field that one man may not always be able to render the desired assistance. Often it is necessary to get suggestions from the faculty members who are most familiar with the particular field under investigation.

In connection with the use of the library it is well to form the habit of recording valuable references on suitable, standard-sized sheets or cards, and to briefly abstract articles for future references. Such matter should be filed and indexed according to some well-developed system.

WM. N. BARNARD,
Chairman of the Library Committee.

Engineering Research at Colleges and Universities

In recent years the educational institutions of this country as well as abroad have taken an increased interest in the field of research work. Few persons outside the immediate departments concerned realize the amount of this work constantly under way, or the practical character of many of the investigations. A glance at Dean Smith's report reprinted in this issue gives one an idea of the variety of subjects treated in one college.

The importance of this work is brought out very well in President Schurmann's report for the past college year. Perhaps the best proof, however, for its usefulness and sound principle lies in the fact that large manufacturing concerns have adopted the research idea and have established laboratories in many parts of the country. In fact so great is the impetus given to commercial research that there is some danger of its swallowing up the purer form of college research. The reason for this is to be found in the better financial backing and the larger pressure brought to bear upon the men who do the work. The drawbacks accompanying these conditions are: That usually the end in view must be of immediate practical value, thus removing the stimulus for the purest research, the search for the complete truth; the work undertaken by one concern is more or less in one line and many profitable and useful side-lines remain hidden; many of the results remain the company's secret and therefore add little to the world's store of knowledge; and finally disregard and semi-contempt is shown towards pure theory. Yet what was looked upon as pure theory yesterday is the father of today's practice. We are glad to note that some concerns at least are outgrowing this narrow practice: are permitting their men to investigate almost any kind of problem, be it pure science or practice; and, what is perhaps still more to be applauded, they permit their men to publish most of their results.

Nevertheless the college remains the most ideal place for research. The absolute freedom to investigate any problem and to keep at it without restrictions as to time and without being rushed, create an atmosphere which is difficult to duplicate in practice.

This is especially true if the work is done under the guidance of an able professor who devotes his entire time to graduate students. In this case the fact that the student's time is usually limited to one or two years becomes an almost negligible factor for the apparatus and results of one student can be taken up by his successor and carried towards completion. In addition the perfect freedom from restraint permit the results to be given a wide publicity, thereby increasing their value proportionally.

The most ideal situation is brought about when practice has its research done in colleges. This would be best accomplished if some of the heads of commercial plants, whose facilities and means for solving their own problems at their own shops are inadequate, would endow fellowships at engineering schools for particular purposes. These fellowships might hold, if necessary, for only a limited time. By this means the commercial plant, the college, and the student would gain from every point of view. Why this opportunity has not been grasped by many of the smaller manufacturers can be ascribed only to ignorance of conditions.

A similar idea which is being used to a limited extent, but far below its possibilities, is commercial testing done in colleges. The Sibley College laboratories are at the disposal of any manufacturer at a nominal cost. The Dean's report shows to what extent this privilege has been used during the past year.

Undoubtedly a big step in the right direction would be the passage of the Newlands Bill "providing for an engineering experiment station in each of the Land Grant Colleges with an annual fund of $15,000 to be

(Continued on page 84)

INVESTIGATION OF THE PROPERTIES OF BALSA WOOD

(Ochroma Lagopus)

By R. C. CARPENTER*

The laboratories of Sibley College made an extended investigation of the properties of balsa wood for the purpose of ascertaining its strength and insulating qualities. This wood is exceedingly light and promises to have an extensive field of usefulness in connection with cold storage structures or rooms in connection with cold storage plants where heat insulation is important. The wood is a tropical wood growing principally in the states of Central America and in the tropical countries of South America.

I found that little information had been obtained by engineers regarding balsa wood and that it was a matter of considerable interest, and for that reason I presented a paper before the American Society of Civil Engineers on June 7, 1916, which gave the results of such information as was available to the writer.† I have extracted a considerable portion of the paper referred to above and present it herewith.

Very little information is available respecting the wood of the balsa tree, which has recently been applied to several practical uses, and, as it possesses properties which make it valuable for many engineering purposes, the writer has thought it of sufficient interest to warrant the publication of the information which he has obtained regarding it. His interest in the wood was excited as the result of investigations as to its properties undertaken more than a year ago, and recently also by a visit to the Isthmus of Panama, where it grows extensively. The wood is remarkable: first, as to its lightness; second, as to its microscopical structure; third, as to the absence of woody fiber; fourth, as to its elastic character, in the sense of recovery from transverse deformation; and fifth, for its insulation qualities for heat. It is the lightest wood commercially useful so far as the writer has been able to ascertain, and it has considerable structural strength, which makes it suitable for a fairly extensive use.

THE WEIGHT OB BALSA WOOD

Balsa wood, when thoroughly dried, has a specific gravity of 0.11. For reference, Table 1‡ shows the relative weights of various woods. Until recently, Missouri cork wood, weighing 18.1 lbs. per cu. ft., was supposed to be the lightest, but recent investigations indicate that balsa wood is much lighter, having a weight of 7.3 lbs. per cu. ft. The ordinary commercial balsa wood is seldom perfectly dry, and because of the moisture content its weight, as appears from a number of investigations made by the writer, will usually be between 8 and 13 lb. per cu. ft. As will be seen from Table 1, however, it is much lighter than cork.

TABLE I

WEIGHTS OF WOODS

Common name	Scientific name	Weight in pounds per cubic foot
Balsa	*Ochroma lagopus*	7.3
Cork	(Bark from cork oak, *Quercus suber*)	13.7
Missouri corkwood	*Leitneria floridana*	18.1
White pine	*Pinus strobus*	23.7
Catalpa	*Catalpa speciosa*	26.2
Cypress	*Taxodium distichum*	28.0
Douglas fir	*Pseudotsuga mucronata*	32.4
Sycamore	*Platanus occidentalis*	35.5
Red oak	*Quercus rubra*	40.5
Maple	*Acer saccharum*	43.0
Long-leaf pine	*Pinus palustrus*	43.6
Mahogany	*Swietenia mahogoni*	45.0
Locust	*Robinia pseudo acacia*	45.5
White Oak	*Quercus alba*	46.8
Hickory	*Carya alba*	54.2
Live oak	*Quercus virginiana*	60.5
Ironbark	*Eucalyptus leucoxylon*	70.5
Lignum-vitæ	*Guaiacum sanctum*	71.0
Ebony	*Diospyrus*	73.6
Black ironwood	*Krugiodendron ferreum*	81.0

CELLULAR STRUCTURE OF BALSA WOOD

The cellular structure of balsa wood, as exhibited under a microscope, differs from that of any other wood known to the writer. All engineers know that wood is made up of a series of interlacing cellular bodies of microscopic size which, when joined together, form fibers which extend both radially and longitudinally. These cellular fibers are interlaced, and, by their form and arrangement, give the wood its strength and physical properties. In ordinary woods the thickness of the walls of the cells is generally a considerable proportion of the diameter. The cells which are parallel to the axis of the tree are made up principally of woody fiber; those which extend in a radial direction usually have a cellulose structure with little woody fiber, and are defined as "medullary rays," or pith cells, because of their position and composition. The microscopic structure of all the woods involves, in addition, the existence of ducts or vessels scattered through the wood in a longitudinal direction; these serve as a circulatory system for the transmission of liquids and gases during the growth of the tree.

Figs. 1 to 3 are reproductions from micro-photographs of balsa (*Ochroma lagopus*). Fig. 1 shows cross-sec-

*Professor of Experimental Engineering, Sibley College.

†Proceedings of the American of Society Civil Engineers, May, 1916.

‡From the *Bulletin* of the Missouri Botanical Garden, August, 1915.

tion, Fig. 2 radial section, and Fig. 3 tangential or longitudinal section. In these illustrations, the ducts or vessels are denoted by (*a*), the medullary rays by (*b*), and the barrel-shaped cells which constitute the longitudinal fiber, by (*c*).

To W. W. Rowlee, Professor of Botany in Cornell University, who assisted in the investigations, the writer is indebted for the micro-photographs and also for the following botanical description:

"*Gross Characteristics.*—In general appearance, balsa wood resembles basswood. As shown by the accompanying micro-photographs, Figs. 1 to 3, its medullary or pith rays (*b*) are uniformly spaced, and are quite prominent in both the radial and cross-sections. In the radial section, Fig. 2, they appear much as in maple or sycamore, as well as basswood, but lack the hardness and susceptibility to polish possessed by these woods. The ducts, pores, or vessels, shown at (*a*), are large and remote from each other, and occur singly, or in grous, in the strands between the pithrays (*b*).

"The lightness of the wood is one of its most striking features. This is due to the thinness of the walls of the elements. There is rather indistinct evidence of annual rings in the cross-section. In the specimens studied, the regular concentric rings, so characteristic of trees of temperate regions, do not show.

"*Minute Structure.*—The pith, or medullary ray cells (*b*) have normal position and form, but the cells are not elongated radially to so great an extent as is usually found in woods. The ducts (*a*) are large, with rather thin, pitted walls. Woody fibers of the ordinary sort seem to be absent in this wood, their place being taken by a cellulose tissue (*c*) very much like the thin-walled tissue of the pith and cortex of ordinary trees.

"The cells (*c*) making up this tissue are barrel-shaped, whereas woody fibers are taper-pointed and relatively much longer. The most remarkable thing about them, however, is their exceedingly thin, unlignified walls. A section of the tissue in question, examined under a microscope, would not be taken for wood, but rather thin-walled cells or 'parmchyma' from the pith or cortex of a stem. The only lignified part is the wall of the duct, and that is relatively weak.

"*Conclusions.*—

"1. The gross structure of balsa wood is in appearance like basswood, poplar, or willow.

"2. Its weight shows that it is fundamentally different from these.

"3. Its minute anatomy is radically different from any wood known to the writer.

"4. What corresponds to the woody fibers, shown at (*c*), are not lignified. They are very thin-walled and soft.

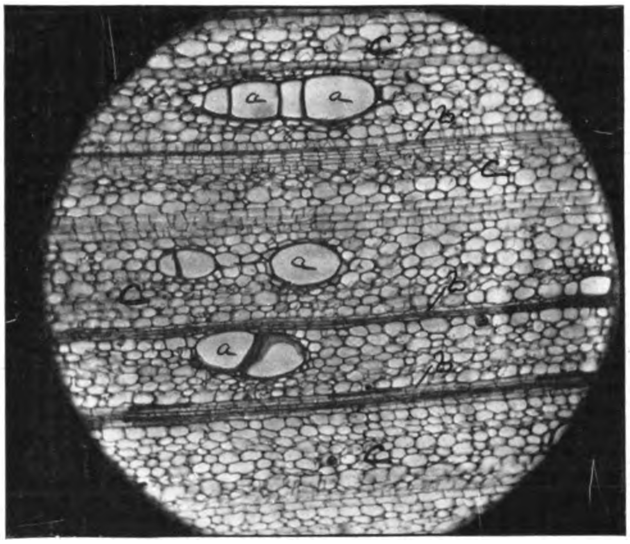


FIG. 1. (*Ochroma lagopus*) CROSS-SECTION, BALSA, ABOUT 78 DIAMETERS, SHOWING (*a*) LARGE VESSELS, (*b*) MEDULLARY RAYS, (*c*) CROSS-SECTION OF LONGITUDINAL CELLS.

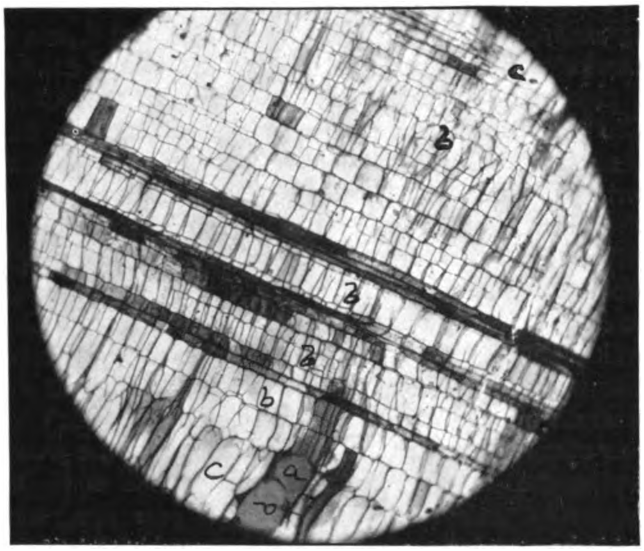


FIG. 2. RADIAL SECTION, BALSA, ABOUT 70 DIAMETERS, SHOWING (*a*) LARGE VESSELS OR DUCTS, (*b*) MEDULLARY RAYS, (*c*) LONGITUDINAL CELL STRUCTURE.

"5. The ducts or pores, shown at (*a*), are weakly lignified, and are pitted. They, however, constitute a very small proportion of the wood.

"6. The pith rays, shown at (*b*), are also thin-walled and not lignified."

THE STRENGTH OF BALSA WOOD

Table 2 shows tests made at Sibley College, and also as reported by Professor Walter S. Leland, formerly of the Massachusetts Institute of Technology.

*Crushing and Compression Tests.**—Three specimens, each 1¾ by 2½ by 4 in., with a cross-section of 4.375 sq. in., gave an average of 2,488 lbs. per sq. in. Another

*Except where otherwise noted, these tests were made at Cornell University.

test of three specimens gave an average of 2 225 lbs. per sq. in.

Three specimens, 1 by 1 by 3 in., crushed with loads of 2 210, 2 380, and 2 530 lbs. per sq. in., respectively.

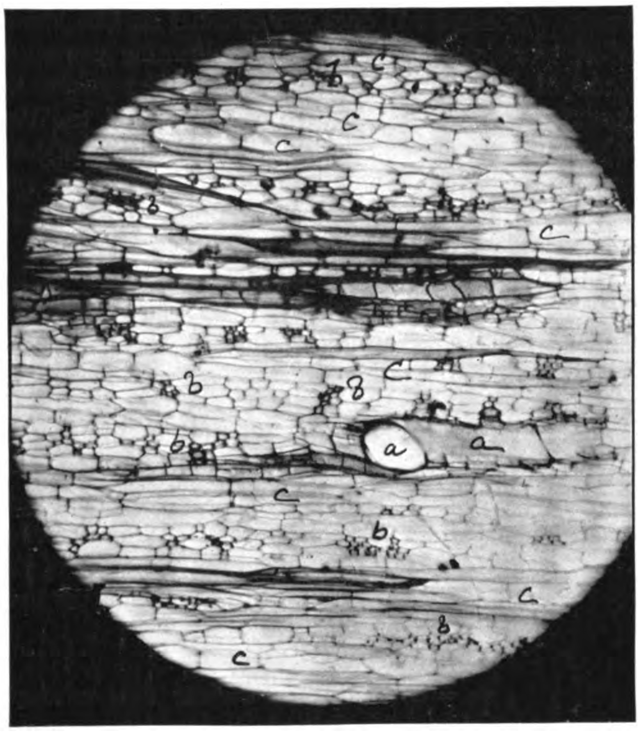


FIG. 3. TANGENTIAL SECTION, BALSA, ABOUT 70 DIAMETERS, SHOWING (*a*) LARGE VESSELS OR DUCTS, (*b*) MEDULLARY RAYS IN CROSS-SECTION, (*c*) CELLS CONSTITUTING BARREL-SHAPED LONGITUDINAL FIBERS.

TABLE II

TRANSVERSE TESTS OF BALSA WOOD

No.	Dimensions in inches	Modulus of rupture	Deflection in inches	Quality	Where made
A	1¾ by 2½ by 20	2 880	....	Medium	Cornell.
B	1¾ " 2½ " 20	3 290	....	Clear	"
C	1¾ " ½ " 20	....	0.847	Clear	"
D	1¾ " ½ " 20	....	1.123	Clear	"
1	5 by 5 by 96	3 500	2	Clear	M. I. T.
2	1¾ " 4½ " 96	3 600	1 5/16	Poor	"
3	1¾ " 4½ " 96	2 900	1¼	Very poor	"
4	3 1/16 " 4⅝ " 96	3 300	2 9/32	Clear	"
5	1⅞ " 5½ " 96	3 207	....	Clear	"

Weight of Specimen *A* ....13.19 lb. per cu. ft.
" " *B* ....10.05 " " " "
Average weight of Nos. 1–5 ....13. 2 " " " "

Two compression tests, of specimens 1 by 1 by 16 in., showed maximum loads of 1 860 and 1 980 lbs., and net compression of 0.69 and 0.55 in., respectively.

One specimen, 5⅞ by 5⅞ by 23 25/32 in. crushed under a load of 40 900 lbs., equivalent to 2 500 lbs. per sq. in.; and one slightly smaller gave substantially the same strength per unit of section as reported by Professor Leland in Table 2.

Professor Leland states:

"The crushing strength seems to be very satisfactory for such wood—about one-half the strength of white pine or spruce.

"These tests show the modulus of rupture to be approximately one-half that of good spruce, and their uniformity clearly shows that the material may be relied on both for direct compression and transverse loads.

"It is very elastic material, and when the load was almost at the breaking point, the load on three of the beams was removed and the beams resumed their original shape.

"It is exceedingly interesting to note that it is practically impossible to split the wood by driving nails through it."

Fig. 4 shows a balsa wood plank supported on horses and carrying two men, the plank being 5½ in. wide, 1¾ in. thick, and 10 ft. 8 in. between supports. The weights carried were 187 and 200 lbs., respectively. The maximum deflection at the center was about 10 in.

TRANSMISSION OF HEAT

Specific Conductivity.—The Bureau of Standards, Washington, D. C., has determined the "specific conductivity," e, of balsa wood with the following results, expressed in British thermal units per hour, per square foot per inch of thickness, per degree Fahrenheit of difference in temperature between the surfaces.

e for untreated balsa wood.	e for treated balsa wood.
0.394 B. t. u.	0.422 B. t. u.
0.352 "	0.350 "
0.403 "	0.424 "
	0.383 "

The lowest results obtained with both the treated and the untreated wood indicate a "specific conductivity" of 0.350. The higher results in other cases are to be attributed to imperfect specimens, or to imperfect contact of the heat measuring devices. The Bureau of Standards uses electrical methods in measuring the heat supply and the temperature of the surfaces of the material, in order to eliminate all surface losses. The "specific conductivity" corresponds to e in the equation,

$$H = \frac{e}{x} (\theta - \theta'),$$

where x = the thickness, θ = the temperature of the entering surface, θ' = the temperature of the discharge surface, and H = the heat transmitted.

FIG. 4. DEMONSTRATION OF THE ELASTIC DEFORMATION OF BALSA WOOD.

Heat Transmitted by Melting Ice.—Table 3 gives the results of the writer's investigation of heat trans-

mission by determining the quantity of ice which melted in boxes made of balsa wood and other materials under known differences of temperature measured inside and outside. The results were reduced to British thermal units transmitted per square foot of mean surface between the outside and inside surfaces of each box, per degree of difference of temperature of the air inside and outside, per hour of time, which correspond to the "coefficient" of heat transmission, k, in the equation,

$$H = k\,(T - T'),$$

in which T = the temperature of the air on the entering side, and T' = the temperature of the air on the discharge side, the other symbols being as before stated. The coefficient, k, differs from the "specific conductivity," e, of the previous equation as it is dependent on the surface as well as the conduction capacity for heat transmission.

Relation Between "Specific Conductivity" and "Coefficient of Heat Transmission."—It is evident that the quantity of heat transmitted through any body is equal to that passing in succession each heat-resisting part. For example, if heat passes through a simple homogeneous body from a higher to a lower temperature, and from the air on one side to that on the other side, it must overcome: (1) the resistance of the entering surface, (2) the resistance of the material composing the body, and (3) the resistance of the surface from which it emerges. The surface resistances, (1) and (3), are overcome by radiation and convection, the interior resistance, (2), by conduction. The surface capacity for transmitting heat may be considered as equal to the convection capacity plus the radiation capacity. The coefficients of radiation for many materials are known accurately, and may be calculated for different temperature conditions by the application of Stefan's or DuLong and Pettit's Law. The coefficients of convection are not known so accurately, but the values as stated by German engineers appear to give reliable results.

TABLE III

HEAT TRANSMISSION EXPERIMENTS IN SIBLEY COLLEGE. TESTS MADE BY MELTING ICE

No. of test.	Thickness of wood, in inches.	British Thermal Units per Square Foot per Degree of Difference of Temperature of Air.		Kind of material.
		Per hour k.	Per 24 hours k'.	
1	2	0.121	2.90	Balsa wood, treated.
2	2	0.120	2.89	Balsa wood, treated.
3	2	0.122	2.93	Balsa wood, untreated.
4	2	0.192	4.61	White pine.
5	2	0.102	2.45	Nonpareil cork, extra.
6	2	0.122	2.93	Balsa, single boards, treated.
7	2	0.121	2.90	Balsa, double boards, at right angles.
8	2	0.1194	2.67	Armstrong, XX-cork blocks.
9	3	0.191	2.18	Balsa wood, treated.
10	2	0.1194	2.87	Balsa wood, treated.
11	1	0.199	4.78	Balsa wood, treated.
..	1/16	0.660	15.82	Bare zinc, 1/16 in. thick.

k = coefficient of heat transmission per degree Fahrenheit of difference of temperature of air near the sides, per square foot, per inch of thickness, per hour;
$k' = 24\,k$.

The Bureau of Standards has given the name "specific conductivity" to the quantity of heat conducted, in British thermal units per square foot per hour, per inch of thickness, per degree of difference of temperature of the walls; and this term is used in this paper. This method does not consider surface losses, which vary with conditions. Engineering computations of heat transfer must usually be made by considering the temperatures of the air on the two sides, and require a knowledge of a coefficient of heat transfer per unit of area, per inch in thickness, per degree of difference of temperature of the air on each side, represented herein by k.

The following equations give the relation between "specific conduction," e, and "coefficient of heat transmission," k. They are rational, and are recognized by French and German engineers as accurate. In the equations which follow,

H = heat transmitted per unit of surface per unit of time;
e = "specific conductivity," or heat transmitted per degree of difference of temperature of the sides of the material, per unit of time, per inch of thickness;
x = thickness;
a_1 = coefficient of surface flow entering the body;
a_0 = coefficient of surface flow leaving the body;
k = coefficient of total heat transmission per degree of difference of air temperature, per inch of thickness;
$T - T'$ = difference of temperature of air on two sides;
$\theta - \theta'$ = difference of temperature of material on two sides;
$t = T - \theta$ = drop of temperature entering the material;
$t' = \theta' - T'$ = drop of temperature leaving the material.

As the flow of heat is continuous, we have the following expressions, all equal to each other, as representing the flow through a single wall of homogeneous material without air space, per unit of surface, per unit of time:

Flow by conduction through interior ... $H = \frac{e}{x}\,(\theta - \theta')$ .... (1)
Surface flow entering .... $H = a_1\,(T - \theta)$ .... (2)
Surface flow leaving .... $H = a_0\,(\theta' - T')$ ... (3)
Total heat transmission .... $H = k\,(T - T')$.... (4)

From these we can readily deduce

$$\frac{1}{k} = \frac{1}{a_1} + \frac{1}{a_0} + \frac{x}{e} \quad \ldots\ldots\ldots\ldots (5)$$

from which the relation between k and e can be computed, provided the values of a_1 and a_0 are known.

The foregoing equations apply to a single thickness without air space; but it is easy to calculate, by the same process of reasoning, the heat transmission through walls made up of various materials with or without air spaces. In the case of a wall made up of two

different materials with an air space between, we should find by calculation

$$\frac{1}{k} = \frac{1}{a_1} + \frac{x}{e} + \frac{1}{a_0} + \frac{1}{a_1'} + \frac{x}{e'} + \frac{1}{a_0'} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

The temperature of the surface can be readily deduced by transposition in the equations given, thus, from Equation (2),

$$\theta = T - \frac{H}{a_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The surface transmission coefficients have been worked out carefully for numerous cases by Rietschel and other German engineers. These are given by Kinealy,* in English units, as follows:

$$a = c + d + \frac{(40c + 30d)\,t}{1\ 000} = c\,(1 + 0.004\,t) + d(1 + 0.003\,t)$$

$c = 0.82$ for still air;
$c = 1.03$ for air with moderate velocity;
$c = 1.23$ for air with high velocity.

VALUES OF d.†

Brickwork	0.74	Iron, rusted	0.69
Mortar	0.74	Cast iron, new	0.65
Plaster of Paris	0.74	Sheet iron, polished	0.009
Stone masonry	0.74	Brass, polished	0.053
Wood	0.74	Copper, polished	0.033
Paper	0.78	Tin, polished	0.045
Glass, dry	0.60	Zinc, polished	0.049
Glass, wet surface	1.09	Zinc, dull	0.10

For thick walls and poor conductors, t is so small that it can be neglected. Rietschel gives values of t, for windows, as 36; for brickwork 5 in. thick, as 14; for brickwork 30 in. thick, as 5, for wooden doors, as 2.

Comparison of "Specific Conductivity," e, with "Coefficients of Heat Transmission," k.—The following computation is based on an assumed value of the "specific conductivity" (e = 0.35), as determined by the Bureau of Standards, a_0 and a_1 as computed from the preceding equations, and coefficients, which are as follows:

First, For a Single Wall Without Air Space.—

$$a_0 = a_1 = 0.82 + 0.74 + 0.01 = 1.57$$

These values substituted in the general equation, give

$$\frac{1}{k} = \frac{1}{1.57} + \frac{1}{1.57} + \frac{x}{e}.$$

This, solved for $e = 0.35$ and for values of $x = 1$, 2, and 3, gives the following results:

"Specific conductivity."	Thickness in inches.	"Coefficient of heat transmission."
$e = 0.35$	$x = 1$	$k = 0.242$
$e = 0.35$	$x = 2$	$k = 0.143$
$e = 0.35$	$x = 3$	$k = 0.1015$

Second, Single Balsa Wall, Ice in Zinc Box; Representing Test Results.—A box of balsa in still air, having thicknesses of 1, 2, and 3 in., respectively; melting ice confined in a dull zinc box, $\frac{1}{64}$ in. thick, the inside of which is in contact with the ice but separated from the balsa wood by an air space. These conditions correspond to those of the ice-melting test of which the results have been stated, and to which Equation (6) applies. For these conditions, $a_0 = 0$, and $\frac{x'}{e_1}$ is so small that it is negligible.

Substituting numerical values, we have

$$a_1 = c + d = 0.82 + 0.10 + 0.92$$

$$\frac{1}{k} = \frac{1}{1.57} + \frac{1}{1.57} + \frac{x}{0.35} + \frac{1}{0.92}.$$

This, solved for different values, gives the following results:

"Specific conductivity."	Thickness in inches.	"Coefficient of heat transmission."
$e = 0.35$	$x = 1$	$k = 0.192$
$e = 0.35$	$x = 2$	$k = 0.124$
$e = 0.35$	$x = 3$	$k = 0.091$

Table 4 gives a comparison of the determinations of k by computation (assuming $e = 0.35$) and test.

TABLE IV

RESULTS WITH BALSA WOOD BOX

"Coefficient of Heat Transmission," k.
"Specific Conduction" e.

Thickness of box, in inches.	By computation, assuming $e = 0.35$ (for 1 hour).	By Test, Melting ice, in a Zinc Box, Inside Balsa.	
		k for 1 hour.	k for 24 hours.
1	0.192	0.199	4.78
2	0.124	0.121	2.90
3	0.091	0.091	2.18

Engineers using insulating material for cold storage generally express the heat transmission coefficient on the basis of the heat, in British thermal units transmitted per degree Fahrenheit of difference in temperature of the air on the two sides, through material 1 in. in thickness, and for a period of 24 hours, which corresponds to k' in Table 4. The coefficient for 1-in. material is generally assumed as equal to twice the result obtained in a test of 2-in. material. In practice, only materials 2 and 3 in. in thickness are used, so that the coefficient obtained on such a basis, though not scientific, gives results which are fairly close. On such a basis, the "coefficient of heat transmitted" through balsa wood, per inch of thickness, computed from the Bureau of Standard tests, is 5.98; and, as determined by ice-melting experiments in Sibley College, is 5.80.

THE HABITAT

In a recent trip to the Isthmus of Panama the writer found balsa trees growing commonly in all the cleared spaces which were not under cultivation in the Canal Zone. Most of these trees were of small diameter, and evidently quite young, and in every instance they were found in the newly started jungle which has recently been allowed to grow over a goodly part of the Canal Zone since the Canal has been completed. In some cases these trees were growing vigorously

*"Formulas and Tables for Heating," New York, David Williams Company.

†This table is the same as the Péclét table (see E. Péclét, "Traite de la Chaleur") for coefficients of radiation reduced to English units.

in the masses of material sliding into the canal. The tree is characterized by a large leaf, from 14 to 30 in. in greatest length, and by the peculiar seed pods which it bears when it reaches a larger size. Excellent

FIG. 5

evidence was obtained that the balsa tree grows very rapidly, and attains a diameter of from 12 to 14 in. at an age of 4 or 5 years. Rear-Admiral H. H. Rousseau, M. Am. Soc. C. E., now in charge of considerable construction work in the Canal Zone, told the writer that a balsa tree which was growing near his house at Culebra attained dimensions approximating 12 to 14 in. in diameter and from 40 to 60 ft. in height, in about four years. A considerable quantity of balsa of large size is to be found near the cleared plantations along the Chagres River, and in various other places near the Atlantic Coast and the banana plantations.

The result of an investigation of the forests of a number of tropical countries, by Mr. Herbert Paschke, undertaken for Capt. A. P. Lundin, indicates that balsa trees are found in considerable quantities in Honduras, Costa Rica, Colombia, and Jamaica, and there is abundant evidence that it grows vigorously in most of the tropical countries of South America. The report referred to indicates that the balsa or *ochroma* is entirely a second-growth wood, and is never found in the virgin forest, except as an isolated tree or two where clearing has occurred. The writer also learned, from his visit to the tropics, that forests composed of any one species do not exist in tropical countries, as they are found in the United States. Tropical trees always grow individually or by themselves, and very rarely in close proximity to other trees of the same species. This fact makes it necessary to spend considerable sums for transportation in gathering any tropical timber, as great distances through the jungle have to be traversed in order to obtain the timber of a single tree.

It is thought that the first person to make an extended commercial use of balsa wood was Capt. A. P. Lundin, President of the Welin Marine Equipment Company, and formerly connected with the Pacific Mail Steamship Company. From his travels in tropical countries, Capt. Lundin knew of the extreme lightness of this wood, and its value as a buoyancy material in life preservers and lifeboats was suggested by its properties. When he undertook to apply the wood practically, however, he found that it was of little value because it absorbed moisture in great quantities, and also because it soon rotted, and also warped and checked when worked. He then undertook the discovery of some means of treating the wood which would render it water-proof and also prevent it from changing its shape. After testing nearly every method that had been suggested, Col. Marr's method of treating woods, which had been recently patented, was finally successful. In this method the wood is treated in a bath, of which the principal ingredient is paraffin, by a process which coats the interior cells without entirely clogging up the porous system. The paraffin remains as a coating or varnish over the interior cell walls, preventing the absorption of moisture and the ill effects as to change of volume and decay which would otherwise take place; it also prevents the bad effects of dry rot, which follows the use of any surface treatment for preserving wood of the balsa type.

The Marr process tends to drive out all water and make the wood water-proof; it improves the quality of being readily worked with tools, without material increase of weight. The treated balsa wood has been used extensively by the Welin Marine Equipment Company in the manufacture of life preservers, fenders for lifeboats, and for structures requiring insulation from heat, as in the refrigerating compartments of vessels, and in ice boxes.

PLANIMETER THEORY

By G. B. UPTON*

Among the minor instruments frequently used by the engineer, the planimeter is the one above all others requiring mathematical knowledge for the understanding of its operation. The following theory, in explanation of the action of a planimeter, has been used for some years in the Sibley laboratories.

The purpose of the instrument is the ready and rapid evaluation of areas of irregular plane figures. To effect this the outline of the operation is: (1) the "pole point" at one end of the instrument is fixed in position with regard to the figure to be measured (according to a rule to be developed later); (2) the "tracing point" at the other end of the instrument is set at a marked starting point on the perimeter of the figure, and a reading of the record wheel of the instrument is taken; (3) the tracing point is guided around the perimeter of the figure, in a clockwise direction, until it has returned to the starting point; (4) a second reading is made of the record wheel. From the difference of the two readings of the record wheel the area is found. The clockwise direction of tracing is conventional, to give a positive increase of second reading over the first. Counter clockwise tracing merely gives negative readings, of the same numerical value as in clockwise tracing, but apt to be confusing.

The essential parts of the common polar planimeter are: (1) The "guide arm." This has at one end a needle point which, pushed into the working surface, fixes that end and makes it the "pole" point, or fixed center. At the other end of the guide arm is the "hinge point," which joins the guide arm to (2), the "tracing arm." The hinge has a wide range of motion. The length of the guide arm from pole point to hinge point is arbitrary. The tracing arm extends from the hinge point to the "tracing point," a blunted or rounded point which is guided by the operator around the perimeter of a figure to be measured. Attached to the tracing arm at any convenient place, usually near the hinge point, is (3) the "record wheel." The axis of this wheel must be parallel to the mathematical line from hinge point to tracing point. The record wheel proper is a disc with a narrow edge almost, but not quite, sharp; the diameter of this wheel edge must have a certain definite relation to the length of the tracing arm from hinge point to tracing point. Usually this length of the tracing arm is adjustable through a slight range, to make possible a correct relation to the diameter of the record wheel. Attached to the record wheel, or on the same axis and revolving with the record wheel, is a drum of diameter slightly less than that of the wheel, and graduated uniformly in 100 or 150 divisions, parts of a revolution. A vernier scale fixed on the tracing arm, and paralleling the edge of the drum, enables the operator to read to one-tenth of a graduation, corresponding to $\frac{1}{1000}$ or $\frac{1}{1500}$ of a revolution of the record wheel. The dimensions of the tracing arm and record wheel are so chosen that one graduation of the drum corresponds to some decimal subdivision of the desired unit of area. There is often a second graduated drum, or disc, driven by a bevel or worm gearing from the axis of the record wheel, and keeping track of its total number of revolutions.

The general mathematical principle involved in the operation of a planimeter may be stated as that of generation of areas by the motion of a line, the motion being restrained to one plane. The motion of a point in a plane surface, like a pencil or pen point on paper, visibly generates a line in the plane if the point leaves a trace behind to mark its wanderings. To such lines generated by the motion of a point we can apply the geometric notion of direction, ascribing to the line a positive or negative sign as well as magnitude of length. From an arbitrary starting point as zero we may legislate that components of motion to the northward and eastward shall be positive, to the southward or westward negative. The final distance of the wandering point from the starting point, or zero position, is measured by the algebraic sum of north and south, and east and west, components of the motions between start and stop, and is independent of the actual path and path length travelled.

The concept of generation of areas in a plane by the motion of a line is of the same kind as that of generation of lines by motion of a point. The idea of directed areas, of positive and negative signs, is a bit harder to get. The ordinary window-shade gives an excellent example of algebraic summation of positive and negative areas. The rod at one edge of the shade is the generating line; the roller is the zero position of the generator. When we move the rod down from the roller we expose a positive area of the shade, equal to the length of generator times its motion perpendicular to itself. When we move the rod up we generate negative area, which cancels some of the preceding positive. The net area of shade exposed at any instant is the algebraic summation of the preceding positive and negative motions. (The analogy is defective in that we cannot go through zero to intrinsically negative areas of window-shade.)

The generation of area by motion of a straight line in a plane is readily represented by the methods of calculus. Any infinitesimal motion of the line can

*Assistant Professor of Experimental Engineering, Sibley College.

be analyzed into three, and only three, possible components. A slide of the line in the direction of its own length generates no area. A rotation of the line around one of its ends as center, through an angle $d\theta$, generates an area (a narrow triangle) $\delta A = \frac{1}{2} \cdot L \cdot L d\theta = \frac{1}{2} L^2 d\theta$, with L the length of the line. A motion of the line perpendicular to itself, through the distance dP, generates the area $\delta A = L \cdot dP$. The complete differential of area generated by any infinitesimal motion of the line is then $dA = L \cdot dP + \frac{1}{2} L^2 d\theta$. When the line goes through any series of motions the net area generated is $A = L \cdot \int dP + \frac{1}{2} L^2 \int d\theta$. If the final position of the generating line coincides with its initial position, as it always does in the operation of the planimeter, then $\int d\theta$ must be either zero or some integral multiple of 2π radians.

Using a geometrical method of representation of the motion of the generating line in a plane, the general scheme of generation of areas is given in Fig. 1. The initial position of the line is m n. The end m of the line moves clockwise around the perimeter of the area A while n moves clockwise around B; finally the line returns to its starting position. If areas generated are positive when dP is upward, then area A is generated positively, B negatively, and C, between A and B an the extreme position of the line, both positively and negatively. The net area generated is A + C — C — B or A — B. C cancels because it is passed over alternately in opposite directions.

The next step is to make the area B vanish by reducing it to a line, as in Fig. 2. Then the net area generated is A, C cancelling and B being zero. This represents the ordinary operation of the planimeter. The "generating line" of the mathematical theory is to be identified as the "tracing line," from hinge point to tracing point, in the planimeter. The tracing point is carried by the operator around the perimeter of some figure to be measured. Meanwhile the other end of the tracing line, the hinge point, moves back and forth on a guide line. The guide line in a polar planimeter is an arc of a circle, about the pole point as center, because of the action of the guide arm connecting pole point and hinge point. So far as theory goes the guide line might have any arbitrary form; the arc of a circle is the most convenient and the easiest to realize mechanically. We may say that the function of the guide arm is to constrain the hinge point, one end of the tracing line, to a definite path. If the hinge point runs back and forth on a line, the area of its path is zero, and the net area generated by the tracing line is solely the area outlined by the tracing point. Further, the final position of the tracing line being the same as the original, and the line having merely oscillated in angle but not turned around, the $\int d\theta$ has the value zero, and the calculus formula for the operation becomes $A = L \int dP$.

The value of the $\int dP$ is furnished by the record wheel. Fastened to the tracing arm, with its axis parallel to the tracing line, any motion of the tracing line perpendicular to itself must register as a rotation of the wheel. If the motion reverses so also does the rotation of the wheel; the wheel adds up algebraically the perpendicular motions of the tracing line.

To find the value of one division of the graduations of the drum or record wheel we may now transform the formula $A = L \int dP$ into $A = LR$, where R is the net distance turned through by the edge of the record wheel. If D is the diameter of the edge of the record wheel its circumference is πD. The true area causing exactly one turn of the wheel is then $A = LR = L \pi D$. This area corresponds to 100 or 150 (usually 100) graduations on the record drum. Hence the value of one division or graduation is $\frac{L\pi D}{100}$ or $\frac{L\pi D}{150}$, as the case may be. The method of design to make the instrument read in any desired system of units is obvious. It is necessary simply to make $\frac{L\pi D}{100}$ (or

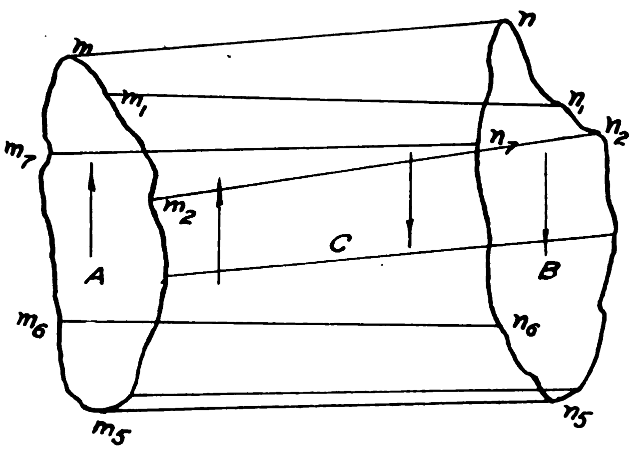


FIG. 1

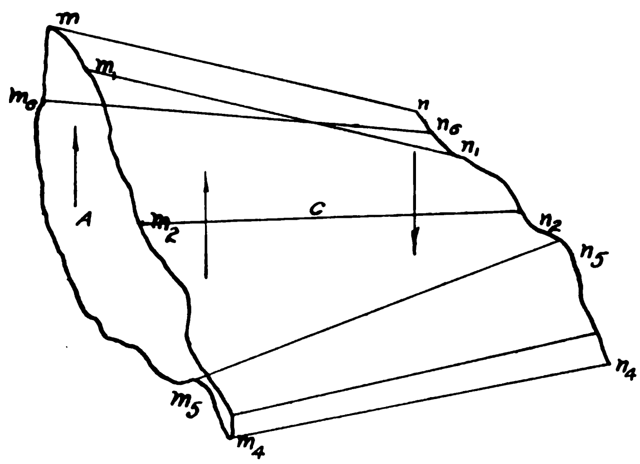


FIG. 2

$\left.\frac{L\pi D}{150}\right)$ some decimal multiple of the desired unit of area, by suitable choice of values for L and D. Commonly D is about three-fourths of an inch, and L somewhere from three to six inches, values in this range having been found to make a compact and convenient instrument, operating stably and well.

If the values of L and D are such that the value of $\frac{L\pi D}{N}$, (N being the number of graduations on the record drum) does not come out a decimal multiple of the desired unit of area, we may fall back on the fundamental fact that $\frac{L\pi D}{N}$ is the true value of one graduation, or the "constant' of the instrument. For example, let D be 0.637 inches, L 4.25 inches, N = 100. Then $\frac{L\pi D}{N} = \frac{4.25 \times \pi \times 0.637}{100} = 0.085$; and area in square inches for figures measured with that instrument will be 0.085 times the number of graduations read from the instrument as the value from integration of the figures. This scheme of finding a "constant" from L, D, and N is useful in two ways. It is a very good way to check the construction of the instrument, by measuring L and D and noting N. Also it shows that the same instrument may have any number of "constants," having one for each unit of length applied, as feet, inches, centimeters, etc.; and "constants" may be found too for integrating areas on drawings, maps, etc., made to known "scales", so that the planimeter readings, times a proper constant, give areas in desired units.

Lacking a micrometer caliper for the measurement of D, the next best way to check the constant of a planimeter is by using it on a known area. The best form of "known area" is the circle (not, as many suppose, the square). It is best to make the instrument itself draw the circle. A "guide link" may be improvised from a piece of stiff paper or cardboard about one-half inch wide and two or three inches long. Near one end of this guide link push down through it a thumbtack to make a center of motion. Punch a minute hole (pinhole) near the other end of the link. Set the tracing point of the planimeter in the pinhole, just to the point of sticking through. Fix the pole point of the planimeter in a proper position, and integrate the circle generated by the tracing point as it is guided by the link. Keep the link stretched always outward lightly from the center. This method of link guiding eliminates largely the errors of hand guiding of the tracing point around the perimeter of penciled circle. The mean of several planimeter values for the circle shows what the planimeter reports as the area in terms of planimeter graduations. Pick up thumb-tack and link; a light grooved trace will be found as the track of the tracing point. Measure the diameter of this circle in several directions; compute the area and compare with the instrument reading to find the "constant."

It has been shown that the function of the record wheel is to measure the net motion of the "tracing line" perpendicular to itself. The wheel cannot do this unless the axis of the wheel is parallel to the tracing line. Occasionally, through defective construction, the axis of the wheel gets out of parallel. Then the "parallelism error" enters into the readings of the instrument. Motions of the tracing line in the direction of its own length cause the wheel to rotate, when they should not affect it at all; and motions of the line perpendicular to itself are not truly recorded by the wheel. The resulting error is a variable one, depending on the size and shape of the figure measured, and on the set-up of the instrument with regard to the area (or placing of the pole point). The parallelism error cannot be corrected for by any constant. It can be discovered by inspection of the instrument, if bad; one can readily locate the tracing line from hinge point to tracing point and notice whether the axis of the wheel parallels it nor not.

The parallelism error so varies with the placing of the pole point with regard to the figure that it is quite possible to reverse the sign of the error by shifting the pole point. This fact leads to the experimental method of check for the presence and magnitude of the parallelism error. Using the same scheme of a link-guided circle described above for finding the constant, make two sets of integrations of the circle; one with the pole point as close in to the circle as can be managed, the other with the pole point as far away as can be managed. If the two sets agree the parallelism error is absent. If the "constant" has been found independently from $\frac{L\pi D}{N}$, it will probably be found, when parallelism error is present, that for one of the extreme pole point positions the readings of the planimeter are too low, and for the other position too high. For some intermediate position of the pole point the parallelism error will vanish for that particular figure. A little more consideration of the matter will show that parallelism error tends to vanish when the average value of the angle between tracing line and guide line (or arm), during the integration of a figure, is a right angle. Hence the practical rule for setting up the planimeter: put the tracing point approximately at the center of gravity of the figure to be measured, open out the arms until the angle between tracing line and guide line (not necessarily the same as that between the arms) is about 90°; then fix the pole point. If, with this preliminary set up, the planimeter is not visibly out of parallel, the parallelism error may be entirely neglected.

In the ordinary operation of a polar planimeter the figures measured are small compared to the dimensions of the instrument, so that the pole point lies well outside of the figure, and the hinge point merely oscillates back and forth on a short arc. Such has been all of the operation so far considered in detail. The angular motion of the generating line (the tracing

line) has cancelled out of the operation with the $\int d\theta =$ zero. It is quite possible to operate the instrument, however, so that the $\int d\theta$ is 2π radians, not zero, and the record wheel reading is disturbed by the finite angular component of motion of the tracing line. Such operation occurs when the pole point is placed within the figure to be measured (which must be large compared to dimensions of the planimeter) and in following the perimeter of the figure the tracing point makes a complete revolution around the pole point. The hinge point then has moved in a circle around the pole point as center. Because of the angular motion affecting the record wheel the wheel does not, however, as might at first be thought, tell the difference between the figure measured and the area of the circle made by the hinge point.

This case of operation may be analyzed most readily by noting a certain condition of set-up which would cause the wheel to remain stationary while the instrument runs over a really large area. If the planimeter is set up with the plane of the edge of the record wheel passing through the pole point, and the arms held constantly in this relation while the instrument rotates around the pole point as center, the wheel will not move. It will be running always exactly at right angles to its edge, and therefore give a reading of zero for the operation. Meanwhile the tracing point will have described a large circle around the pole point as center. This circle described by the tracing point is called the "zero circle." It is from this "zero circle" as a base that the instrument measures when the tracing point makes a complete revolution around the pole point. We need only remember that in this case true area = zero circle area + reading, and keep careful track of the reading and its algebraic sign, for the instrument may be backing up.

If the zero circle is unknown, we turn our equation into zero circle = true area − reading, and use for true area a link guided circle, of measured radius or diameter, about the pole point as center. (Use the needle of the pole point instead of a thumbtack as center at one end of the cardboard link). A radius of six to ten inches for the known circle works out well with the ordinary planimeter, in the experimental finding of the zero circle. The radius of the zero circle could also be computed from measurements of the planimeter, on the basis of that set-up which makes the tracing point generate the zero circle.

THE NATURE OF ROLLING AND SLIDING BETWEEN BODIES IN DIRECT CONTACT

LESLIE D. HAYES*

When a sled is drawn along the surface of the earth we unhesitatingly state that it slides upon the earth. In this case each element of the surface of the sled runner comes successively into contact with each contact element of the earth's surface. If we substitute wagon wheels for the runners of the sled and draw it along as before, the wheels will rotate and each element of the surface of the wheel rim will come into contact with but a single element of the earth's surface. We say that the wheels roll upon the earth. These two cases have been designated definitely as *pure sliding* and *pure rolling* respectively. If, instead of drawing this wheeled sled along, we apply force to the wheels and cause them to rotate they may cause the sled to move forward, they may slip at their points of contact with the earth's surface, or both of these conditions may occur either intermittently or simultaneously. This third case has been classed in a general way as *mixed rolling and sliding*. The foregoing definitions are purely qualitative. There is general agreement that, when the slip is all in one direction, the amount of slipping in each case is expressed as the algebraic difference between the lengths of the corresponding contact surfaces of the two bodies, measured from the initial point of contact, but apparently no attempt has been made to express quantitatively the amount of rolling. There does not appear any very important reason why such an expression is needed but the lack of it has led to certain conceptions on the part of students, which, if carried to ultimate conclusions, give results which seem absurd. It was in an attempt to reconcile these results that the author deduced the theory expressed in this article.

It is necessary to define first a unit of measurement. This might be based either upon the progress made by the point of contact or upon the progress made by the center of curvature of the rolling body. The latter has been chosen as the preferable basis for reasons which will appear in another paragraph. A movement of the center of curvature along its path equal in length to the radius of curvature of the rolling body constitutes a suitable unit. Then, in the case of pure rolling, the amount of rolling, R, which has occurred is the distance, L, moved through by the center of curvature of the rolling body, divided by the radius of curvature, r, or $R = L \div r$. If the radius of curvature is not constant this becomes $dR = dL \div r$ (a variable). In general, however, the rolling action is accompanied by a greater or less amount of slipping so that each element of the rolling body comes into contact with more than one element of the mating

*Assistant Professor of Machine Design, Sibley College.

surface which makes the corresponding lengths of the contact surfaces unequal. The effect of this slip, S, is to change the distance moved through by the center of curvature of the rolling body for any given amount of rolling to some new value L′. The usual or positive slip tends to make L′ less than L. If the surface upon which the rolling occurs has a radius of curvature r′ then as shown in Fig. 1

$$L = L' + \frac{r' + r}{r'} S, \text{ or}$$

$$dL = dL' + \frac{r' + r}{r'} dS.$$

That the values for the amount of rolling obtained by the application of this theory are consistent is perhaps most readily shown by concrete examples. In A, Fig. 2, the moving circular body of one unit radius has rolled without any slipping from the position *O* upon the circular fixed member a distance such that the arc of contact on each member is equal in length to the circumference of the rolling body; in B, C, D, and E the rolling body has started from the same position and the length of its arc of contact has remained unchanged but slipping has changed the arc of contact on the fixed member to ½, 0, 3/2 and—½ of that length respectively; in F the moving body has travelled entirely around the fixed member with the same point of its circumference in contact with it at all times; in G the moving body has rolled without slipping so that the arc of contact on each is equal to the full circumference of the fixed member; and in H the moving body has moved around the fixed body keeping at all times the same diameter in a vertical position. The value of each of the terms in the general form of the formula for each of the foregoing cases is given in Table I.

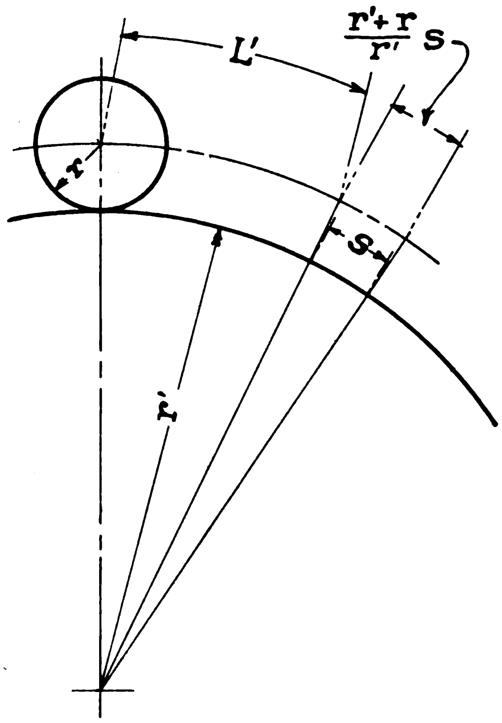


Fig. 1

Table I

Position	A	B	C	D	E	F	G	H
r	1	1	1	1	1	1	1	1
r′	5	5	5	5	5	5	5	5
L′	2.4π	1.2π	0	3.6π	-1.2π	12π	12π	12π
S	0	π	2π	$-\pi$	3π	-10π	0	-12π
$\frac{r + r'}{r'}S$	0	1.2π	2.4π	-1.2π	3.6π	-12π	0	-14.4π
L	2.4π	2.4π	2.4π	2.4π	2.4π	0	12π	-2.4π
R	2.4π	2.4π	2.4π	2.4π	2.4π	0	12π	-2.4π

From these results the value of R is seen to be independent of the amount of slip. The value of *r* and of *r′* each affects the numerical value of R in a constant manner for all cases, but does not affect the nature of the contact between the surfaces.

The possible effect of changing the form of the contact surface of the moving body (changing the value of r) upon the result in case F is illustrated in Fig. 3 and Table II.

Table II

	r	r′	L′	S	$\frac{r'+r}{r'}S$	L	R
A	−5	5	0	-10π	0	0	0
B	−15	5	-20π	-10π	20π	0	0
C	$\pm\infty$	5	$\pm\infty$	-10π	$\mp\infty$	$\infty - \infty$	$\frac{\infty - \infty}{\pm\infty} = 0$

In the three cases A, B and C of Fig. 3 each moving body is assumed to have passed entirely around the fixed member keeping at all times the same point of its surface in contact. Table II shows that the result in each case is the same as in case F of Fig. 2 and that the nature of the contact is unaffected by the radius of curvature of the moving body. We may state, then, that if one element of the moving body comes successively into contact with each element of the fixed body, there is no rolling and the contact is pure sliding.

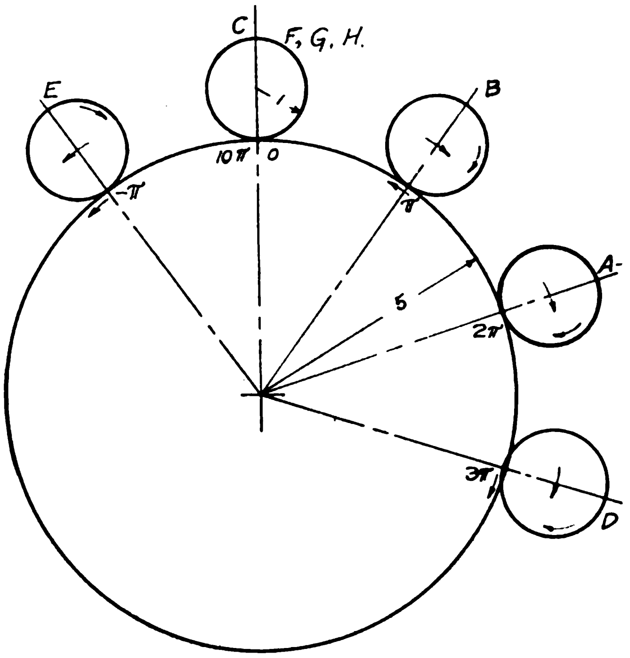


Fig. 2

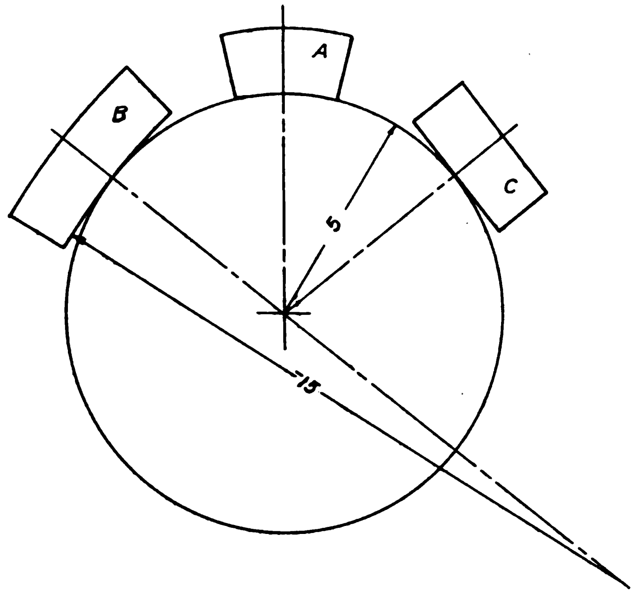


FIG. 3

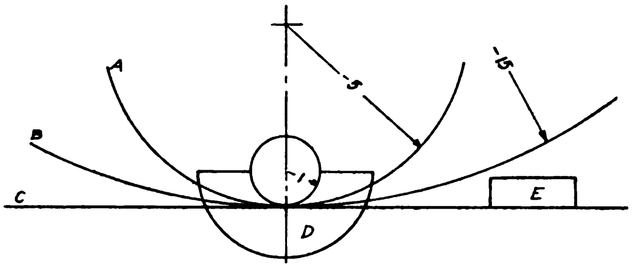


FIG. 4

The possible effect upon cases A and C of Fig. 2 of changing the form of the contact surface of the fixed member (changing the value of r′) is illustrated in Fig. 4, and Tables III and IV. In Fig. 4, for the results given in Table III, the moving body is assumed to have rolled without slipping until each element of its circumference has successively come into contact with some element of the surface of each of the fixed bodies A, B, C and D. Table III shows that the amount of rolling is directly affected by the radius of curvature of the fixed surface and becomes zero when that radius becomes coincident with that of the rolling body. For the results shown in Table IV the moving body is assumed to have turned around once so that all points of its circumference have come into contact with a single element of each of the fixed surfaces. No change in the amount of rolling has been caused by the introduction of the slipping. Case E is the same as case D except that both radii are now infinite. From the foregoing it would appear that if a single element of the fixed member comes successively into contact with each element of the moving body it is not necessarily a pure sliding contact so far as the moving body is concerned. We may conclude, then, that the condition of rolling is not a reciprocal relation between the two bodies in contact as is the case with sliding but is a function of that body only which is considered to be in motion.

TABLE III

	r	r′	L′	s	$\frac{r+r'}{r'}s$	L	R
A	1	− 5	1.6π	0	0	1.6π	1.6π
B	1	−15	1.866π	0	0	1.866π	1.866π
C	1	∞	2π	0	0	2π	2π
D	1	− 1	0	0	0	0	0

TABLE IV

•	r	r′	L′	s	$\frac{r'+r}{r}s$	L	R
A	1	− 5	0	2π	1.6π	1.6π	1.6π
B	1	−15	0	2π	1.866π	1.866π	1.866π
C	1	∞	0	2π	2π	2π	2π
D	1	− 1	0	2π	0	0	0
E	∞	∞	10	−10π	−10π	0	0

Pure sliding between two direct contact bodies has been said to occur "if a point of one of the bodies comes in contact with all successive points of the acting surface of the other (within the limits of its path)". In accordance with this statement case C Fig. 4 and Table IV in which the moving body turns around without advancing was given as an illustration of pure sliding and it was such instances which led the writer to take up the consideration of this point. In order to arrive at the foregoing conclusion it would be necessary to assume that the amount of rolling is proportional to the distance progressed either by the center of curvature of the moving body or by the point of contact along the surface of the fixed member. If the former of these assumptions is made, i.e., R = L′ ÷ r, the results of the eight cases of Fig. 1 would have been as indicated in Table V. These results might be considered reasonable for cases A, B, C and G of Fig. 1 but the results of the remaining cases are apparently absurd. In case D the moving body has had each element in contact once only but has rolled a greater distance. If this be true a decrease in the rotation would not decrease the amount of rolling

TABLE V

	A	B	C	D	E	F	G	H
r	1	1	1	1	1	1	1	1
L′	2.4π	1.2π	0	3.6π	−1.2π	12π	12π	12π
R	2.4π	1.2π	0	3.6π	−1.2π	12π	12π	12π

and we should come logically to case F in which the moving body rolls with its same point always in contact with the fixed member. In case E the moving body has rotated in a positive direction as before but made progress in a negative direction and therefore had negative rolling. In case H the point of contact has travelled around the surface of the rolling body in a negative direction but the rolling has remained of a positive sign. Had the rolling been assumed proportional to the distance progressed by the point of contact the numerical values would have been decreased but there would have been no alteration in the absurdity of the results.

As stated in an earlier paragraph of this article, an assumption might have been made that the rolling is proportional to the distance progressed by the point of contact along the surface of the fixed body plus

the amount of slipping. This would have in no wise affected the nature of the results in Tables I and II for any of the cases of Fig. 2 or of Fig. 3 but would have changed the numerical results. This change in the numerical results, however, changes its nature in case D of Fig. 4, for the conditions either of Table III or of Table IV, the amount of rolling in each case being 2π instead of zero. Case D for the conditions of Table III has been considered rolling when speaking of the generating circle in the generation of the hypocycloid for the tooth of the pinion for pin gears. This result could be accepted without causing any absurdity either for these cases or for case E of Table IV as any finite movement at the point of contact in the latter case would be divided by an infinite radius producing a final value of zero for the rolling.

ABSTRACTS FROM THE PRESIDENT'S REPORT, FOR 1915-16

A new, radical, and highly important change has been made in the government of the University, at the meeting of the Board of Trustees on April 29, 1916, they presented their final report which was adopted by the Board. The resolutions were as follows:

"A. *Resolved*, That the faculty of each college located at Ithaca, except the state colleges, be invited from time to time to select two of its members who, with the dean of such faculty, shall constitute a committee to meet as often as desired with the Committee on General Administration, the Committee on Finance, or the Committee on Buildings and Grounds (according to the nature of the matter) for the consideration of questions affecting the welfare of such college; that the members of such committee other than the dean shall be selected by ballot and for definite terms or as each occasion for conference arises and under such conditions as may be provided by the faculty selecting them.

"B. *Resolved*, That the University Faculty be authorized and invited for and during the period of three years commencing June 1 next to select delegates who shall represent it in the Board of Trustees. Said representatives shall not at any time exceed three in number. They and their successors shall be selected by ballot and for such terms respectively, not extending beyond the period above mentioned, as shall be fixed by the faculty. They shall have the right to meet with the Board of Trustees and the Committee on General Administration and shall possess the usual powers of Trustees, except the right to vote."

The professorial Trustee could not have been given the right to vote without a change in the charter of the University. In practice the limitation is not likely to make the slightest difference in the status or influence of the representatives of the Faculty, as the decisions of the Board are actually settled by discussion. The University Faculty accepted the provision without hesitation, but expressed the hope that experience would indicate the desirability of giving at some later time the right to vote also to Faculty representatives.

At a special meeting of the University Faculty on June 5 on ballot duly had the following professorial Trustees were elected: Professor Walter F. Willcox, Professor Dexter S. Kimball, and Professor John H. Comstock. The terms of these representatives were fixed by ballot.

STUDENTS

The total number of different persons who received instruction in the University in 1915–16 was 7,143. Excluding those enrolled in the Summer Session of the University and in the Summer and Winter Schools and Summer Term in Agriculture, the number of regularly matriculated students pursuing courses leading to degrees was 5,656, an increase of 311 over the preceding year.

These 5,656 regularly enrolled students were distributed among the several courses of instruction as indicated in the following table, which for purposes of comparison covers the three preceding years.

It will be noted that the largest increase over the enrollment of the preceding year is in the College of Arts and Sciences in which the numbers have grown from 1,294 to 1,424. Still more remarkable is the increase in the enrollment in the Graduate School, 482 in 1915–16 as compared with 394 in 1914–15. The nation-wide phenomenon of diminished attendance in engineering schools seems to be passing by at Cornell, as the total enrollment in Civil, Mechanical, and Electrical Engineering is almost the same as last year. The attendance in Agriculture exceeds by 34 that of the preceding year. The marked rise in the enrollment in Veterinary Medicine is largely due to the large class which entered in September in anticipation no doubt of the inauguration of the four-year course in 1916–17.

Year	Graduate School	Arts and Sciences	Law	Medicine	Veterinary Medicine	Agriculture	Architecture	Civil Engineering	Mechanical and Electrical Engineering	Total Exc. Duplicates
1912–13	382	1112	297	150	120	1263	144	503	956	4803
1913–14	383	1194	271	141	131	1462	149	487	902	5015
1914–15	394	1294	245	205	123	1670	163	480	927	5345
1915–16	482	1424	243	216	159	1704	166	450	942	5656

Of the 5,656 regularly enrolled students, 4,922 were men and 734 women. Of the women, 699 were registered in Ithaca during the first term, and 669 during the second.

THE GRADUATE SCHOOL

In the Graduate School the university is exercising its highest function. Enlarging the boundaries of knowledge, it makes its contribution to the progress of civilization. The amazing progress made in Germany during the last generation or two rests very largely on the creative science and scholarship of the German universities. Unfortunately this function of the university has never been appreciated in the United States at anything like its proper value and the Graduate School is everywhere in danger of being submerged by the other divisions of the university which have a close relation to practical life. Even the organization of the graduate school in American universities endangers its efficiency; for the faculty is made up of teachers who are members of other faculties, the greater number of whom devote the larger portion of their time to the instruction of undergraduate students and to the administration of undergraduate departments. The American public thinks of a professor as a teacher of undergraduates. And, as there are a great number of undergraduates in the larger American universities, they monopolize the professor's time, endanger the efficiency of his work with graduate students, and encroach upon his interest in productive scholarship or scientific investigation. It is essential, however, not only to the welfare of the graduate school but to the very life of the university as a whole that there shall be a large body of professors who refuse to be swamped by elementary instruction and to whom the work of promoting scholarship and carrying on research shall be primary and fundamental, not secondary and incidental.

SEMI-CENTENNIAL CELEBRATION

The plans for the Semi-Centennial Celebration in October, 1918, are in charge of a large and representative committee, of which Henry W. Sackett is the chairman. This general committee and its subcommittees are devoting much time and thought and effort to their task. The institution, whose opening is to be commemorated, received directly and indirectly from Ezra Cornell an endowment of over $5,000,000. What one individual, who was poor most of his life and whose fortune never amounted to many millions of dollars, gave to the University fifty years ago might now surely be duplicated by commemoratory gifts from the rich men and women of this State and country whose numbers have increased more than a hundredfold since the days of Ezra Cornell.

FROM THE REPORT OF THE COMPTROLLER

The total income of the University, August 1, 1915, to June 30, 1916, including gifts for residential halls, etc., and excluding state colleges, amounted to $1,982,506.93, of which there was expended, $1,788,828.65, leaving an excess of income over the amount disbursed for the eleven months of $193,678.28.

The income for the year includes $150,000 (part of a total gift of $350,000) received from Mr. George F. Baker on account of construction of Baker Court for housing men students; $25,000 from the alumni of the University through the Cornellian Council for the construction of Founders Hall; and $60,100 from anonymous donors toward the cost of the proposed dining rooms in connection with the residential halls for men. There is also included in this income $200,000, amount of insurance received upon Morse Hall and contents destroyed by fire February 13, 1916. Allowing for the amount of income due special purposes and not available for general expenses, and for reappropriations necessary to meet obligations already incurred, including that portion of the Morse Hall Insurance Fund not appropriated for replacing apparatus and supplies and repairing the building for temporary use, the net deficit for the eleven months was $34,894.59, which, added to the $122,997.15, deficit of income accumulated during the past 13 years, makes an accumulated deficit on June 30, 1916, of $157,981.74.

Had the figures for this report included the month of July, as formerly, we would have shown a surplus current income over current expense for the year of about $5,000, but the dropping from this report of the month of July, which is a large income and small expense month, almost the entire year's expense having been paid within the eleven months herein reported, results in a deficit of $34,894.59 for the period.

This deficit is, in a way, a matter of bookkeeping due entirely to the change of the fiscal year, but it will continue to show in our accounts until made up by gifts or savings.

STATE COLLEGES

The income of the New York State Veterinary College amounting to $86,612.73, and the expense, to $82,864.33.

The State College of Agriculture received during the year from appropriations from the state and from students' fees and sales of products $988,765.53. The expense of the College aggregated $1,026,558.14. The shortage of receipts was due to the delay in receiving, until a few days after June 30, reimbursements from the state of over $40,000 of vouchers, payment of which had been advanced by the University.

REPORT OF THE DEAN OF THE SIBLEY COLLEGE OF MECHANICAL ENGINEERING

To the President of Cornell University:

SIR: I have the honor to submit this report of important matters in Sibley College, outside of routine, for the year 1915–16.

FACULTY CHANGES

In previous reports the desirability of increasing the faculty of Sibley College in the higher and more permanent grades at the expense of the lower and more transient grades has been emphasized.

In organizing the faculty for next year, 1916–17, it has been possible to make progress toward this desired change. Exclusive of shop instructors, the faculty for the present year, 1915–16, consisted of 69 persons as follows: Ten professors, 13 assistant professors, 10 instructors, appointed for two years, and 36 instructors appointed for one year. Assuming that instructors appointed for two years are men who have been tried out and approved as to character and teaching ability, this class may be included with professors and assistant professors as a part of the stable, experienced faculty; thus the faculty may be said to be made up of 33 permanent members and 36 transient members; or of 47.8 per cent of permanent members.

For next year the faculty will consist of 67 persons as follows: 12 professors, 11 assistant professors, 14 two year instructors and 30 one year instructors. This gives 37 permanent members, or 55.2 per cent.

In the reorganization of the faculty the total number has been reduced from 69 to 67, involving more intensive work in two departments; the number of professors has been increased 20 per cent (10 to 12), the number of assistant professors has been reduced by 15.3 per cent (13 to 11), the number of two year instructors has been increased by 40 per cent (10 to 14), while the number of one year instructors has been reduced by 20 per cent. The reduction in assistant professors was not a part of this plan; it resulted from promotion and it is hoped eventually that a large proportionate increase may be made in th s grade.

This change is relatively small, but it is in the right direction and it has been made without increase in the total annual salary expense in Sibley College. This was possible because of the reduction in the total number, and of rearrangement due to death and resignations.

The result of this increased stability in faculty tenure should be increased excellence in teaching and thus greater effectiveness for Sibley College. Further change of this kind should produce similar results, but it can only be made as a result of increased salaries coming from increased endowment.

It is not desired, however, to eliminate what may be called the transient part of the teaching force; for here teachers are trained and tried out; in fact it is virtually a training school for teachers, not only for Sibley College, but for other technical schools.

RESEARCH

During the year research in engineering problems has been carried on continuously, the most important work done falling under the following heads:

An experimental study of the Brinnel method of testing materials for hardness.

A study of the physical properties of lubricating oils, particularly viscosity.

Experiments for determining the coefficient of friction of wood on cast iron at high speeds.

The development and thorough testing of a thermal alarm system.

A study of the clinkering of coal.

Investigation and partial testing of a power plant.

The application of "surface combustion" to iron manufacture.

Characteristics of the LeBlanc pump.

Experiments with carburetors, and automobile engine testing.

Effect of heat treatment on the physical properties of brasses and bronzes.

Experimental investigation of "water-hammer."

Study of aeroplane fabrics.

During last summer vacation an investigation was started on the "Upton-Lewis Fatigue Testing Machine" to determine the best heat treatment of carbon steels to give longest service under repeated stress; this investigation is still under way. Incidentally this work established the unexpected and surprising fact that the number of repetitions of stress at failure bore such definite constant relation to the carbon content, that the latter could be determined from the fatigue test almost as accurately as from chemical analysis. The new and improved machine is now in service, and during the coming summer, a test is planned on carbon steel of constant composition; the object of this test is to check the commonly accepted theory that within certain limits of stress-range materials are safe from rupture by stress repetition.

COMMERCIAL WORK

For many years Sibley College has undertaken to do work in engineering testing on a commercial basis; moreover the making of castings and of machine parts for manufacturers or dealers has become a part of the regular shop work. The income from this source has increased steadily and, during the past eleven months, was about $1400. This money has been applied to maintenance and increase of equipment and thus the College has earned about nine per cent to the funds appropriated by the Trustees for purposes other than salaries.

The wide range and importance of the commercial test work is indicated by the following partial list from the past year:

An investigation of the insulating and other physical properties of Balsa wood.

A study of the relation between coefficient of friction and slip in the transmission of power by belting.

Investigation of the operation of several types of carburetors.

Tests for the efficiency of different kinds of automobile rear axle drives.

Development of a machine for dishwashing.

Numerous tests of machine parts and of material for machines, especially for aeroplanes.

The Department has also tested the underground piping system of the New York State College of Agriculture and an underground conduit for the State at the Custodial Asylum at Newark; and has inspected the heating systems, and made recommendations for improvements, at some charitable institutions.

This whole question of research is of special interest now when the Newlands Bill is under consideration by Congress. This Bill, if passed, would provide an engineering experiment station in each of the Land Grant Colleges with an annual fund of $15,000 to be devoted to the carrying on of engineering research and to the printing and distributing of results. It would seem that the present time of industrial awakening in the United States is peculiarly a fitting time for the establishment of laboratories for such work, and it is urged that all possible legitimate influence should be used to help toward the passage of this bill.

INDUSTRIAL ENGINEERING

The work of the new senior option in Industrial Engineering, outlined in last year's report has been given this year with very satisfactory results. The work was elected by 43 men out of a senior class of 185, and a canvass of next year's seniors shows that 48 men intend entering this department.

A course has been developed that correlates work in the shops and drawing rooms, and "time and motion studies" have been made by students for application to problems in industrial management. Special attention has been given to locating and planning industrial plants and to provision for their managerial organization.

The need for men trained in this engineering field is a growing one, and rapid development and increased usefulness seems assured to this department.

ELECTRICAL ENGINEERING

The first year of the Department of Electrical Engineering under the direction of Professor Gray has been a year of growth and increase in effectiveness. Rearrangements in the laboratories and quite extensive

additions to equipment have been made, and this department promises to become in the near future one of the strongest in Sibley College.

SIBLEY COLLEGE EMPLOYMENT BUREAU

For many years an important function of Sibley College has been to help students at graduation to find places in practical engineering, and also to help alumni to make desired changes. Thus there developed an employment bureau. During the past two years this work has centered in the Dean's office and under Professor Barnard's direction has developed greatly in scope and usefulness.

The past year has been very exceptional in its opportunities for technically trained men. About 50 employers sent representatives to the College to interview members of the senior class, and others would have come had more seniors been available; in addition to this about 150 letters were received from employers seeking technical graduates.

The Bureau, during the university year, issues mimeographed employment bulletins, one or more a week. These are sent to alumni who express a wish to receive them, and also to alumni clubs that have facilities for giving the bulletins publicity. The Sibley Journal of Engineering, which goes monthly to many former students and to others interested in engineering, now publishes brief employment notices. During the second term of this year about 140 employers made inquiry by letter for one or more Sibley alumni to fill positions of various degrees of responsibility.

A demand has also developed for undergraduates students to work during summer vacations. These opportunities are especially numerous this year; about 40 employers have written for men, in some cases requiring large numbers; this demand is probably incident upon the present abnormal industrial situation.

The Employment Bureau bids fair to become of great and increasing importance in the work of Sibley College.

The College was shocked and grieved by the untimely death of Professor Hess. It seemed that the students for twenty years yet, should have had the benefit of his broad scholarship, his extensive practical experience, and his kindly personal influence.

The department has been rearranged so that Professor Albert will take up Professor Hess' work. With his background of engineering practice, and his twelve year term of able service in the department of Machine Design, his success seems assured.

In general, the year has been one of effective work in Sibley College; the need for new laboratory buildings is still an urgent one, but until such need is met, it is the purpose of the faculty to utilize fully the present equipment.

Respectfully submitted,
Albert W. Smith,
Dean of the Sibley College of Mechanical Engineering.

SOME TYPES OF SUSTAINED-WAVE GENERATORS USED IN RADIO TELEGRAPHY

By WILLIAM C. BALLARD*

In the past few years the subject of long distance radio communication has undergone marked changes. Up to a comparatively short time ago practically all long as well as short distance communication was carried on by means of damped wave trains produced by the so-called "spark" transmitter, yet today, with a very few exceptions, every system designed for communication over distances two thousand miles or over is using some type of continuous wave generator.

There are several different types of sustained wave generators in use today differing widely in their fundamental principles, and it may be convenient to divide them into two general classes, one in which the high frequency power is generated by the action of moving and stationary conductors, and the other class in which all the apparatus involved remains stationary. Under the first class we may list the Fessenden, Goldschmidt and Slaby-Arco systems, and under the second heading would come the Poulsen Arc, Vacuum bulb oscillator, and other apparatus of similar type.

This paper will be concerned with apparatus of the first class, while a later paper will cover the second class.

*Instructor in E. E., Sibley College.

FESSENDEN SYSTEM

The Fessenden alternator is perhaps the simplest from the theoretical standpoint since it directly generates a fundamental frequency of 100,000 cycles per second, whereas in the Goldschmidt and Slaby-Arco systems the fundamental frequency of the alternator is not the radio frequency.

The construction of this type of machine is extremely interesting on account of the mechanical difficulties encountered and solved. This machine is of the inductor alternator type; that is, both alternating and direct current windings are placed on the stator, and consequently slip or collector rings are eliminated from the rotor. In order to more clearly grasp the inductor principle on which the machine operates, let us imagine a piece of soft iron bent into the shape of a horseshoe with a winding "A" on one leg carrying direct current and a winding "B" on the other connected to a volt meter. The flux linking with the "B" coil will be determined by several factors; the dimensions of the iron, its magnetic properties, the current in coil "A", and lastly the presence or absence of a keeper or armature across the two poles. As long as the flux remains constant through coil "B"

there will be no indication on the voltmeter, but just as soon as the flux is increased, the voltmeter will swing in one direction and if the flux is decreased there will be a swing in the opposite direction.

If the current in coil A is constant, and we place a keeper or armature across or between the ends of the horseshoe, the flux will increase due to the fact that magnetic "resistance" of the flux path has been decreased, the portion of the path which was originally through air has now been replaced by iron whose magnetic "resistance" or reluctivity is many times less than that of air; likewise as the armature is removed the reverse action takes place. The Fessenden alternator then is simply a combination of a large number of the electro-magnets and coils conveniently arranged so that by rotating a steel disc at a very high speed this action may be produced in a large number of coils at a very high frequency. The stator of this machine is of hollow rectangular cross section as indicated in Fig. 1, and the rotor is a sheet of steel about twelve inches in diameter. In the outside edge of the rotor are cut some three hundred radial slots, and the same number are cut in the stator. When the rotor occupies a position in which the teeth on the rotor are exactly opposite those on the stator the reluctance of the magnetic path is a minimum and the action of the exciting winding will produce a maximum flux threading through the teeth and consequently, also through the coils wound around the teeth; but when the rotor has moved by the width of a slot, then the slots of the rotor are opposite the teeth of the stator and the flux is reduced to the minimum value. Thus in the coil wound around the teeth of the stator an E.M.F. will be induced whose value will vary through positive and negative maxima every time the rotor moves over a distance of a slot and tooth. In order to reduce air friction to a minimum the slots or spaces between the teeth on the rotor are filled with phosphor bronze whose magnetic properties are practically the same as those of air. The rotor is driven by a direct current motor through a gear box at a speed of about 10,000 revolutions per minute, and delivers a normal output of about 2 KW. Machines of much larger capacity are now being developed. Transmitters employing this type of apparatus are of the utmost simplicity since the entire transmitter consists of only motor, alternator, and key, and perhaps an inductance coil to tune the antenna frequency to that of the alternator. The antenna is directly connected to one terminal of the alternator while the other terminal is grounded, the key generally being placed in the field circuit.

GOLDSCHMIDT SYSTEM

The Goldschmidt alternator was developed by Dr. Rudolph Goldschmidt, an eminent German electrical engineer, and differs from the Fessenden alternator in the fact that the fundamental frequency is not the frequency at which power is delivered to the antenna circuit.

The Goldschmidt machine generates a fundamental frequency of 10,000 cycles per second and by a so-called "reflection" phenomenon this fundamental frequency is increased to 40,000 cycles per second. It has long been noticed in single phase alternator operation that a voltage ripple of double the normal frequency will be superposed on the D. C. exciting circuit. A technical discussion of the exact reason for this phenomenon would be out of place here, so we will simply accept it as a fact. Now suppose by some means we could greatly augment this double frequency current in the field circuit. If it were sufficiently great, we would produce a current of triple frequency in the armature circuit since by using double frequency as exciting current we would add normal frequency to the exciting current due to the rotation of the machine. This in turn would reflect back on the D.C. exciting circuit as a quadruple frequency voltage. This in the case of the Goldschmidt alternator, is conducted to the antenna circuit and represents the useful output of the generator. In order to make the double and triple frequency wave

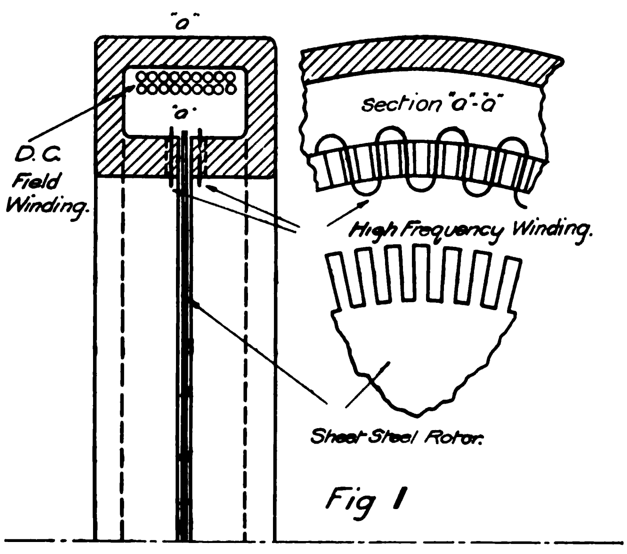


Fig 1

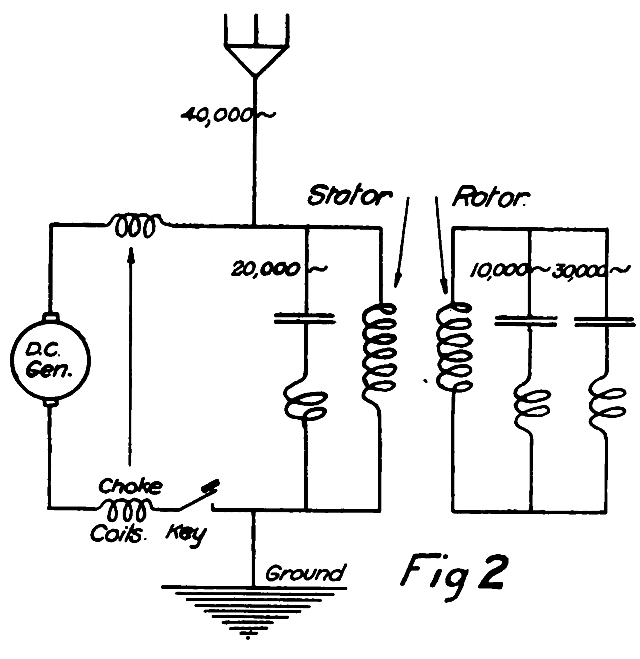


Fig 2

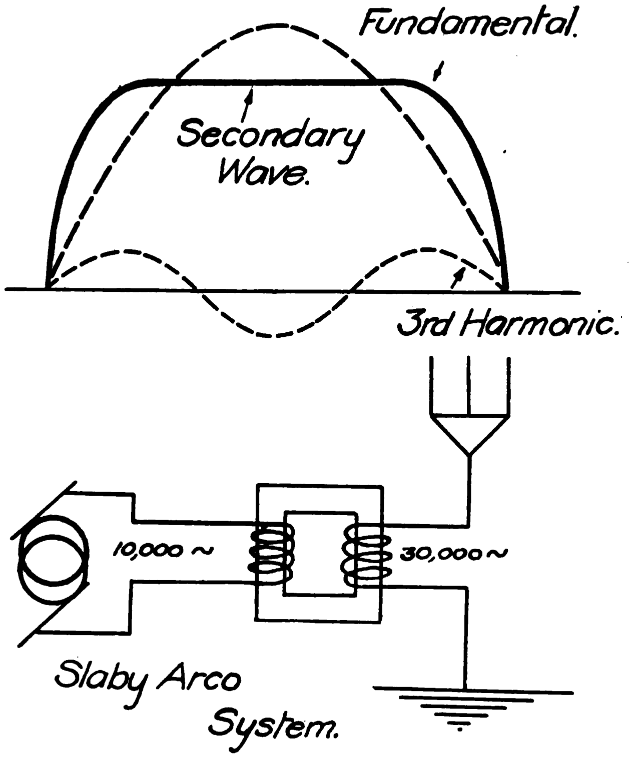


Fig 3.

of sufficient amplitude to eventually produce the quadruple frequency voltage, the circuits as indicated in Fig. 2 are shunted around the rotor and stator windings, the natural frequency of each of these combinations of inductance and capacity being indicated. Some constructional details of this machine may be of interest. From the exterior it resembles any high speed alternator of its rating, but in order to minimize leakage the air gap is made very small, being something less than a millimeter in the alternator in use at Tuckerton, N. J., the rotor being about three feet in diameter and weighing five tons. The laminated structure is made of electrical steel stampings of two mills thickness, nearly one-tenth the thickness of ordinary electrical steel stamping. Each stamping is separated from its neighbor by a very thin sheet of paper. Normal speed is 4,000 r.p.m.

The machine in use at Tuckerton, N. J., gives reliable daylight communication with a similar station at Eilvese, Germany, with a power input of about 100 K.W. It is claimed that this machine is capable of even greater power. A novel form of power control possible in this type of apparatus is the insertion of the key in the D.C. field circuit, whereby it is possible to control the entire generator output by opening and closing a circuit of approximately one-twentieth its value.

SLABY-ARCO SYSTEM

The Slaby-Arco system used in the Telefunken station at Sayville, N. Y., resembles the above system in that the fundamental frequency of the alternator is again about 10,000 cycles per second; but in this system, the frequency amplification is produced by the use of static transformers.

The fundamental theory involved in the operation of this apparatus, hinges around the fact that almost any "flat topped" voltage wave can be divided into two constitutents, one consisting of a pure sine wave of the fundamental frequency, and the other of an approximate sine wave of three times the fundamental frequency. Hence the 10,000 cycle current is conducted into the primary of a bank of transformers whose secondaries are connected to the antenna-ground circuit. Now the antenna circuit is so designated as to give minimum impedance to 30,000 cycle wave but almost infinite impedance to the 10,000 cycle wave. In addition the cores of the transformers are designed to operate well above saturation thus producing a flat topped wave, which as Fig. 3 indicates may be resolved into the fundamental and the third harmonic or triple frequency wave. The very high impedance to the fundamental wave dampens this wave out of the antenna circuit almost entirely while the triple frequency current to which very low impedance is offered attains a very high value.

Thus we are able to produce an effectual 30,000 cycle alternator without encountering problems more difficult than those concerned with a 10,000 cycle machine.

The Sayville station maintains reliable communication with a similar station at Nauen, Germany, a short distance from Berlin.

(To be continued in the next issue)

EXPERIMENTS TO BE MADE AT THE EXPERIMENT STATION, UNIVERSITY OF ILLINOIS

One of the largest of the Mikado type of freight locomotives is being mounted on the locomotive testing laboratory of the Engineering Experiment Station, University of Illinois, for an extended series of tests.

The Railway Engineering Experiment Station has entered into a cooperative arrangement with the International Railway Fuel Association, and the United States Bureau of Mines to conduct tests with various sizes and grades of coal used for fuel. The Baltimore and Ohio railroad has loaned one of its newest freight locomotives for the purpose. This huge locomotive weighs, with its tender, a total of 464,000 pounds. The testing laboratory is designed to permit the locomotive to be operated at any desired speed and at any power output under the same conditions as prevail in practice, while its performance is recorded by means of automatic equipment for measuring tractive effort, water consumption, fuel consumption, smoke production, and other factors which will enter into the investigations.

The Baltimore and Ohio Mikado type of freight locomotive has eight driving wheels, each carrying a load of 28,000 pounds, two pony truck wheels and two trailer truck wheels. It carries a steam pressure of 190 pounds per square inch, has a fire-box seven feet wide, and ten feet long, is 85 feet long, and delivers a pull or tractive effort of 54,500 pounds at its draw-bar.

Samples of coal to be used will be taken from Illinois mines and will be graded according to present commercial sizes ranging from the so-called slack and run-of-mine up to the commonly used "2 x 6 lump." Later, it is contemplated, tests will be made with a coal ground to an impalpable powder or flour which will be injected into the fire-box by means of a specially designed blower. Tests will be made with both hand firing and automatic stoker firing.

It is the expectation that these tests will establish information which will enable a railway to determine how much it can afford to pay for the different grades and sizes of coal, and which grades and sizes will produce the best results under given operating conditions.

The ultimate purpose of tests of this character which the University of Illinois is carrying on in many lines of activity is to provide the basis for the fuller and more economical utilization of public resources. In these locomotive tests it is thought that the incidental benefits which may come to the public in the possible decrease of the smoke nuisance may alone justify the extensive work involved.

The tests will be conducted under the direction of E. C. Schmidt, head of the Department of Railway Engineering and will be in the immediate charge of J. M. Snodgrass, Assistant Professor of Railway Mechanical Engineering, and O. S. Beyer, First Assistant in the Engineering Experiment Station.

W. F. M. Goss, Director.
Urbana, Ill.

FIG. I

ENGINEEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Gray, Prof McDermott, Prof. Albert, Prof. Wells, Prof. Ellenwood, Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Pertsch, H. W. Brown, F. C. Tappan, J. F. Wait.

Graphic Studies of Ultimate Analyses of Coals, Bureau of Mines Technical Paper No. 91 by O. C. Ralston.

This paper graphically presents by trilinear co-ordinates the analyses of various kinds of coal, reduced to a moisture-free, ash-free and sulfur-free basis, so that $C + H + O = 100$ per cent. It is based on 10,000 analyses made by United States Geological Survey and data from other sources. On the chart the anthracite, semianthracite, semibituminous and other coals, fall into certain definite fields with little over-lapping and the plotted points fall in a narrow band across the diagram, which not only gives the C, H, and O percentages and the available hydrogen, but, by means of "isocalorific" and "isovolatile" curves, also shows the calorific value and volatile content.

The applications of the trilinear co-ordinate diagram are based on the fact that in any equilateral triangle (Fig. 1) the sum of the three perpendiculars from any point, p, to the three sides of the triangle is a constant, which can be made 100 per cent. Thus the three co-ordinates of the point in Fig. 1 for $C_6H_{10}O_5$ show the percentages of C, H and O in this carbohydrate. Similarly the perpendicular co-ordinates for the H_2O point shows one part H to eight parts O and the absence of C. Also note that the points for other compounds of only two elements, such as CO_2 and CH_4, fall on the sides of the triangle. The line from C to the H_2O point is for the Carbohydrates, $C_x(H_2O)_y$, which have no available hydrogen for combustion.

Any non-equilateral triangle can be used in a similar manner (see Fig. 2) provided the perpendicular distances from the corners to their opposite sides represent 100 percent.

The coal analyses all fall in the shaded region of Fig. 2. This region is shown to larger scale in Fig. 3 which, in addition to giving the percentages of C, H and O for any point, also shows the carbohydrates present. The available H is the difference between the total H for any point (1) and that for the carbohydrate having same percentage of O (as given at 2). By drawing lines through points of equal calorific value and through those of equal percentages of volatile, isocalorific and isovolatile lines are obtained as in Fig. 4.

A point can be located on the chart if any two of the following quantities are known: percentages of C, H, or O, calorific value, or volatile percentage. After locating the point, the other quantities can be read, the available hydrogen can be found, and the classification of coal can be determined.

The older the coal, in the geological process of formation, the farther it is to the left on the chart. The variation in composition and calorific value with age is clearly shown. The division lines between different fields are not perpendicular but are oblique across the band of dots.

A careful consideration seems to show that the errors in the diagram are probably within the total experimental errors to be encountered in the analyses.

The paper also discusses: residues from the heating of coals under atmospheric and under high pressure; coking coals; hydrogen as an index of coking quality; residues from oxidation; coal constituents, fractions

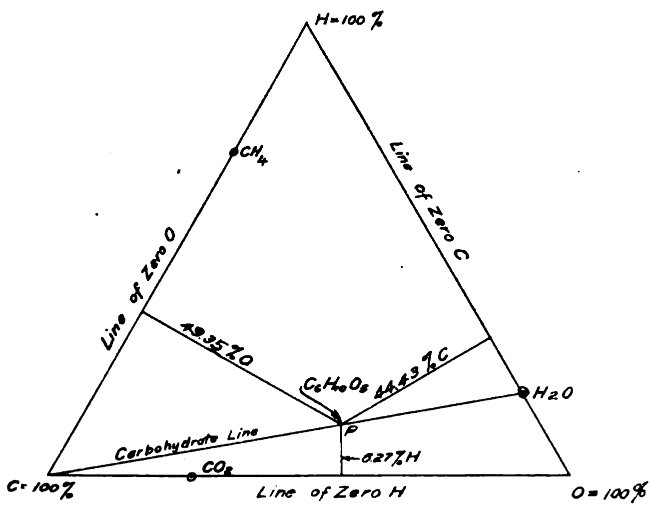


Fig 1

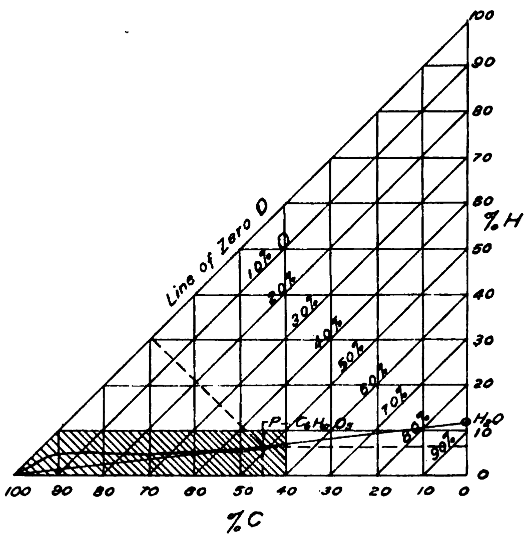


Fig 2

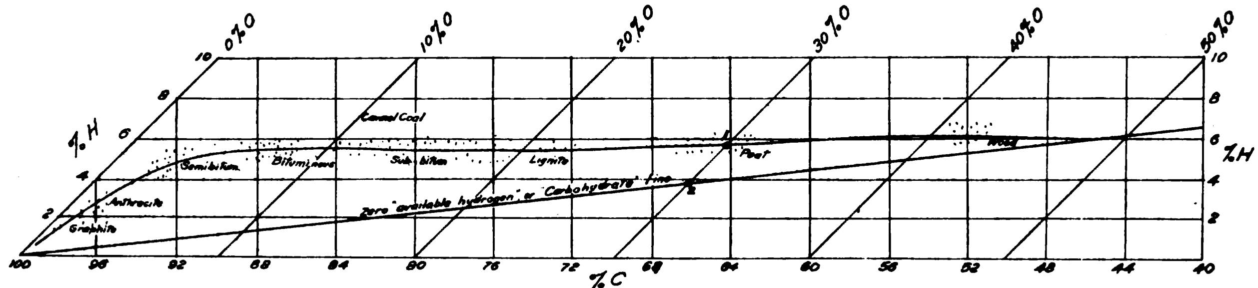


Fig. 3 Grouping of Coals. (C+H+O=100%)

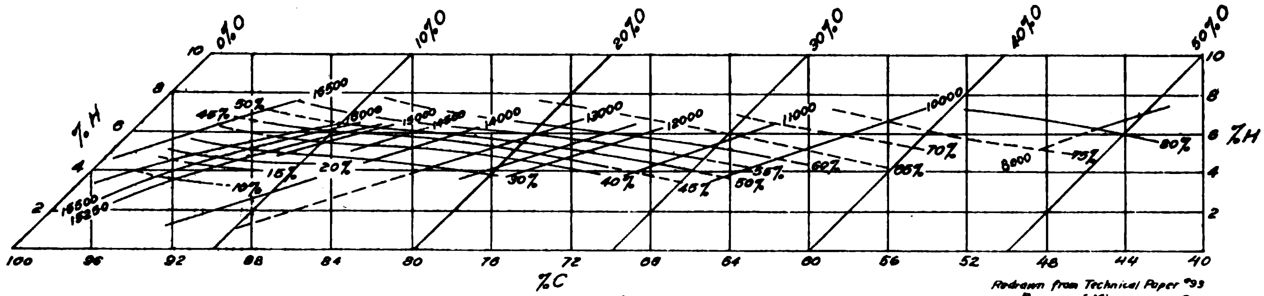


Fig. 4 Isocalorific and Isovolatile Curves.

Redrawn from Technical Paper 93 Bureau of Mines

and residues. Also, it gives a valuable list of publications on the subject.

The illustrations in this review have been redrawn. In the Bulletin, Figure 3 is a large scale drawing showing hundreds of points, many of which are necessarily omitted from the smaller drawing given herewith.

Clinkering of Bituminous Coal by F. C. Hubley; **Power**, October 10 to November 7.

In general, a standard fuel is specified in terms of proximate analysis, sulphur content and heating value; and a price per ton for this standard is agreed upon, a bonus or penalty being provided for grades of fuel above or below this standard. As a rule no particular mention is made of clinker forming properties, or at best, a clause is inserted providing for the rejection of the fuel provided steam pressure cannot be maintained with it under ordinary conditions of operation. Under this system of fuel purchase it frequently happens that a coal will earn a larger bonus than its steam-producing ability warrants, all costs being considered. If a clinkering test were devised, from the results of which it would be possible to indicate or predict the clinkering tendency of the fuel, an additional clause could be inserted in the usual form of specifications, which should protect the buyer from this trouble.

In order to have an accurate knowledge of a fuel, it is necessary to determine the length and position on the temperature scale of the fusing range of the ash and the nature of the fusion. These data, together with knowledge of the maximum rate of combustion and the corresponding furnace temperature, can then be used in the design of a proposed boiler plant, or for the purpose of intelligent selection of fuel for an old installation.

The ordinary conception of the term "fusing point" as applied to a compound, namely, a fixed temperature at which transition from a solid to a liquid state occurs, is misleading, and inapplicable to most substances. The term "fusing point" cannot be fixed or defined, but the term "fusing range" is capable of precise definition and experimental determination. In the following discussion where reference is made to "fusing point" it is intended to denote an arbitrary temperature in the fusing range.

The Seger cone method of temperature determination is subject to certain limitations and sources of error. The principal objections to the cone test are: (1) The personal equation. (2) The lack of any definite record, other than inspection, of the different stages of viscosity throughout the softening range. (The specification of the fusing point alone will not suffice for an effective specification; some note of the rate of change in viscosity throughout the softening range must also be made). (3) Use of a binder in forming the cones (because its effect on the ash fusion is variable).

In attempting to devise a more rapid and accurate method, it would appear that if a sample of ash be formed into a hard pellet under considerable pressure and this pellet placed in a furnace under a slight compression, the variation in thickness of the pellet under a steadily increasing temperature will be a measure of the rate of softening at any temperature, the first movement indicating the beginning of the fusing range and the final stage being complete fluidity of the sample. To perform such a test, an instrument called the fusiometer has been devised. The proceedure is as follows:

A sample of coal is crushed to pass a 60-mesh screen and burned down at a dull-red heat (approximately 1,250 degrees F.) to fine ash. The test pellet, which is cylindrical in form, 5-8 inch in diameter and from 7-16 inch to 11-16 inch in height, is formed in a hand press designed to exert a unit pressure of approximately 25,000 pounds per square inch. Under this pressure the dry pulverized ash is compressed into a hard cylinder without the use of a binder. In the fusiometer the test pellet is held centrally in the

furnace. A carbon rod with weights rests on the pellet and exerts upon it a unit pressure of 1.5 pounds per square inch. Any vertical movement of the carbon rod due to softening of the test pellet is magnified twelve times on the movement scale. Temperature measurements are made with a platinum-rhodium thermo-couple. The furnace is gradually heated at the rate of from 50 degrees F. to 100 degrees F. per minute, simultaneous temperature and scale readings being taken at half-minute intervals. Negative movements of the pointer will indicate expansion of the carbon rod up to the first softening of the ash pellet. The experiment is continued till the final collapse of the pellet.

The observations are plotted with temperatures as abscissa and the movement scale as ordinates. The resulting curve is parallel to the temperature axis at the first softening of the ash, becoming parallel to the axis of the movement scale at or near the melting point, thus giving a diagram of the complete fusing range of the ash under test. An arbitrary point in the fusing range may be selected and called the "fusing point" of the ash. The writer suggests using for this purpose the temperature at which the pellet has collapsed, due to softening, to one-half its original height.

In the calibration of the instrument, test cylinders of pure metals or standard substances having sharply defined melting points are used. For this purpose nickel and copper were selected, as the fusiometer working-temperature range is between 1,400 degrees and 3,000 degrees F.

In predicting the probable clinkering action of a coal, two general factors are used: The length of the softening range and its position on the temperature scale in relation to the working temperature range of the boiler fire; and the physical nature of the fusion throughout the softening range.

Bituminous-coal ashes appear to be divided generally into three classes:

(1) A long-range ash has a softening range that coincides approximately with the working-temperature boiler fire and causes the greatest losses from clinker formation. The formation is always of a tough and gummy nature and in arching over the dumping grate of a stoker, between the bridge-wall and the main grate, makes cleaning of the fires most difficult.

(2) A short-range ash, melts suddenly to great fluidity, and gives trouble only when its final melting point is reached.

(3) A variable-range ash sometimes reaches a great fluidity at the final temperature, but expands to a greater or lesser extent just previous to final softening. The clinker is consequently brittle, or "rotten," and if formed at a temperature not too much below the average fuel-bed temperature, will give little trouble in removal, although causing a somewhat dirty fire.

These three types of ash fusion are best represented in the shape of the curves by the fusion tests on red oxide of iron, ferrous sulphide and calcium sulphate. The article shows many fusion curves.

The following factors each have an effect on the results of the experiments: (1) General method; (2) atmosphereic conditions; (3) effect of binder; (4) preparation of the sample; (5) rate of heating.

In formulating specifications to control the clinkering tendency of coal used in steam boilers, many factors must be established and related to one another:

(1) A standard laboratory test for ash fusion must be established.

(2) The relation between results of the standard laboratory test and those obtained in practice in the boiler fuel bed must be determined. (While the large steam user is interested in what occurs at 2,250 degrees F., or the fuel-bed temperature corresponding to a boiler operating at rating, he is much more concerned with the possibility of steam failure at his highest peak loads.)

(3) The final item to be established is the form of clause, based on the foregoing information, to be inserted in the coal specifications. If 2,700 degrees F. or over is specified for the so-called "melting" point of the ash, it is probable that this specification alone will be ample protection against clinker formation. However, this figure would greatly restrict the buying field in some localities. Where the melting point is specified at 2,600 degrees F. or under, it would appear necessary to include some mention of viscosity or nature of fusion to have the specification effective.

Design of Carbureters by E. N. Percy in **The Gas Engine,** November, 1916. The beginning of a series of articles on carbureter design in which the author proposes to describe the basic principles involved, and to illustrate with curves showing the various characteristics of the different fuels. In this issue the variables entering into the carburetion process are discussed, and the following charts are printed: Flow of water and petroleum products through a carbureter nozzle at different temperatures; vapor pressure of various fuels at different temperatures; weight of various hydrocarbon vapors to saturate 100 lbs. of air at 14.7 lbs. pres. calculated from vapor pressures; adiabatic compression curves for various sp. heat ratios plotted between temp and pressure; time in seconds required for carburetion (vaporization in air) for different liquid fuels with different excess coefficients.

Diesel Engines for Power Plants by Chas. Legrand abstract of a paper before the American Institute of Mining Engineers, in **The Gas Engine,** November, 1916. This article describes a Diesel installation at the Burro Mountain Copper Company at Tyrone, New Mexico, consisting of two 5-cylinder, 2-cycle oil engines of 1200 H. P. sea-level rating, the largest of their type in the United States. The engines are used to generate current for general mine work. Details of operation, cost of fuel and reliability are given.

Boiler Explosions, Power, Nov. 7, 1916. Explosions occurring between July 1, 1915, and July 31, 1916. List gives date, place, plant, time of day, kind of boiler, pressure carried, size, number persons killed and injured, property loss, and probable cause.

The Nature of the Chemical Atom. By Willett L. Harden. **Science Nov. 10, 1916.**

The author gives a brief, but excellent discussion of the important experiments and calculations which have been made by many different persons in the last few years, to determine the structure of the atom. This is certainly one of the most difficult and important problems with which scientists are working, and yet the author shows, with complete references and in simple language, the main points thus far developed in this work.

The article itself is practically an abstract of the entire subject and is therefore a valuable reference for engineers. It is so concise that to attempt further condensation was considered inadvisable, and thus certain paragraphs have been quoted in full as indicating some of the startling and interesting developments in this field.

The conception of the atom became an important factor in chemical science early in the nineteenth century, when Dalton discovered the laws of definite and multiple proportions and announced his well-known atomic theory. He found that when one chemical element combines with another, it combines in a definite proportion, or some integral of that proportion. It was only natural that Dalton should have assumed this definite proportion which he called an atom, to be an indivisible ultimate particle; and it was only natural that this theory should have prevailed throughout most of the nineteenth century, for among the most prominent characteristics of the atom are its individuality and its permanency. It behaves in many respects like an indivisible particle.

Recent investigations, however, into the phenomena of the cathode rays, Lenard rays, canal rays, the Zeeman effect in the spectrum, X-rays and radioactivity have thrown a flood of light on the constitution of matter, and we now know that the atom is very complex in its structure. We know that certain chemical elements are undergoing changes which involve the actual disintegration of the atoms, a phemomenon accompanied by an evolution of energy far greater than that of any other known phenomenon. It has been definitely determined that in the partial disintegration of the atoms, where the atom mass is reduced only a few per cent, there is set free, in some cases, more energy in the transformation of one pound of an element than is set free in the combustion of one hundred tons of coal. Notwithstanding this enormous evolution of energy, these spontaneous, atomic disintegrations are apparently uninfluenced by external conditions, and move along with as much precision and law as the movement of the stars in their orbits. These remarkable phenomena and the intimate relation of electricity, radiant energy and chemical phenomena to atomic structure have brought the problem of the nature of the atom into great prominence in scientific literature.

The experiments of Crookes on the electric discharge in high vacua may be said to have opened the way for the experimental evidence of the complex nature of the atom. Plücker, Hittorf, Goldstein and others had previously investigated this subject, but the results did not become far reaching in their influence on scientific theories until Crookes published the results of his earlier observations in 1879.

The discovery of X-rays by Röntgen on 1895 gave a great impetus to the investigation on the electric discharge in high vacua. When the cathode rays are suddenly stopped by matter of any kind X-rays are produced. These rays are a form of radiant energy. The X-rays apparently originate in the interior of the atom, and each atom emits X-rays which are characteristic of its own structure.

Omitting some less important observations, we now come to the work of J. J. Thomson, 1897. He determined experimentally that the particles of the cathode rays are neither atoms nor molecules, but are negatively charged particles, or corpuscles as he called them, much smaller than the atom. These experiments showed conclusively that the atom has a complex structure. Thomson measured the amount the particles, or electrons as they are now commonly called, are deflected by magnetic and electric fields of known intensities, and in this way determined the velocity of the particles and the ratio e/m where e represents the charge and m the mass of a particle. This ratio has been determined by different experimenters, and has been found to be about 1.77×10^7.

Regardless of the source of the electron, the ratio e/m is constant, and is much larger than the corresponding ratio for the hydrogen ion. The latter ratio is 9,649, or almost 10^4. From the values of these two ratios, it is evident that the charge of the electron is much larger or its mass is much smaller, than that of the hydrogen ion. Thomson and others have determined the magnitude of the charge of the electron and found it to be of the same order of magnitude as that of the hydrogen ion. The value generally accepted for this charge is 4.7×10^{-10} electrostatic units, or 1.59×10^{-20} electromagnetic units. If the charge of the electron is equal to that of the hydrogen ion, it is evident from the ratios given that the mass of the electron is only about 1/1800 that of the hydrogen ion or atom.

Since the discovery of radioactivity by Becquerel in 1896, and the actual separation of radiuum from its ores by Mme. Curie, many eminent chemists and physicists have contributed to the investigations on radioactivity, and various radioactive substances have been discovered and isolated. In every case it has been found that radioactivity is caused by a spontaneous disintegration of the atom, a sort of an atomic explosion accompanied by an unparalleled evolution of energy.

Three types of radiations are given off by radioactive substances, the alpha rays, beta rays and gamma rays. The gamma rays are a form of radiant energy similar to X-rays.

The beta rays consist of negatively charged particles which are identical with the particles of the cathode rays or electrons. The beta particles are thrown off with enormous velocities, almost equal in some cases to the velocity of light. These high velocities have made it possible to determine more definitely the nature of the mass of the electron. Kaufmann and Bucherer have both determined the velocities and masses of beta particles moving with different velocities. They found that the mass increase is equal to the calculated increase in the mass of a moving electric charge.

These results indicate clearly that the mass of the electron is entirely electromagnetic in its nature, and that the electron is in reality a disembodied electric charge. There is considerable experimental evidence to show that all electric charges are made up of some integral multiple of this charge, and that all electric currents are due to some kind of movements of the electrons. If we substitute the values of e and m in the equation $m = \frac{2}{3}(e^2/a)$, we obtain 2×10^{-13} centimeters as the value of "a" which represents the radius of the sphere of action of the electron. This value probably does not exceed 1/20000 of the diameter of the atom.

The alpha rays from radioactive substances also consist of particles, but of an entirely different nature from that of the beta particles. They are slightly deflected by a magnet, and in the opposite direction from that of the beta particles, thus showing them to be positively charged. The ratio of the charge to the mass, that is e/m has been determined and found to be about 4820 which is one-half the value of e/m for the hydrogen ion. The charge carried by the alpha particle is equal to about 9.3×10^{-10} electrostatic units, which is twice the charge of the hydrogen ion.

The counting of the alpha particles has confirmed in a remarkable manner previous estimates of the number of atoms and molecules in a given quantity of matter. This difficult experiment was performed by Rutherford and Geiger, who constructed an apparatus which would automatically magnify several thousand times the electrical effect of individual alpha particles. They found that one gram of radium emits 3.4×10^{10} or thirty-four billion alpha particles per second, and that one gram of radium in equilibrium with its products emits 1.36×10^{11} alpha particles per second.

The enormous number of atoms in a given quantity of matter may be illustrated in the following manner. If the atoms of hydrogen and oxygen in one cubic inch of water were arranged uniformly 1/100 of an inch a part in a single layer, they would cover all the continents of the earth several hundred times.

As already observed, radioactivity is a property of the atom. It is caused by a disintegration of the atoms. There is, however, no gradual disintegration. Each atom of a radio-element is stable until it undergoes a sort of an explosion and ejects an alpha or beta particle, which changes it to a different atom and a different chemical element. Each radio-element has its own characteristic radioactive constant which represents the fraction of the whole amount which disintegrates in unit time. The reciprocal of this constant represents the period of average life. This period varies from a very small fraction of a second to several billions of years for the different radio-elements.

In the disintegration of the radio-elements we have definite evidence of the changes of various elements into other elements. These transformations have brought into prominence again the problem of how various chemical elements have been built up, and the problem of transmutation again becomes a legitimate problem for the chemist to investigate. When we consider the unparalleled amount of potential energy associated with the atom, and the intimate relation of radiant energy and electricity to atomic structure; and when we consider that the supply of energy is the most fundamental problem with which mankind is concerned, and that the energy which supplies the world to-day is being derived largely from a rapidly diminishing supply of fuel stored up in the past, it is evident that atomic structure is one of the most fundamental problems with which science is concerned.

I know it would be presumptive to assume that we shall sometimes be able to utilize the energy which is stored up in the atom, and, on the other hand, it would be equally presumptive to assume that the atom is the barrier beyond which science cannot go. The history of science contains numerous examples of these barriers which have been placed by scientists themselves, and which in many cases have fallen before the conquest of these same scientists. Maxwell said the atom is incapable of growth or decay, of generation or destruction. We know now that certain atoms are disintegrating, and new atoms forming continually. Less than a century ago scientists assumed that a "vital force" was essential in the formation of organic compounds. Today thousands of such compounds are being synthesized in the laboratory and many useful products are being made which, so far as known, the "vital force" has never produced. When Hertz succeeded in producing electromagnetic waves which are now the basis of wireless telegraphy and telephony, he thought it would be impossible to make use of such waves to transmit signals to any great distance. And so on, the unknown and apparently the unknowable of one generation may become the commonplace knowledge of the next. We do not know to what extent we shall be able to solve the mysteries of the atom, and we are unable to even predict the consequences of such a discovery. We know that the problem is beset with almost insurmountable difficulties, and that our knowledge on the subject can never reach finality.

The interior of the atom is the common ground where chemistry and physics meet, and there is probably no problem before the scientific world today that offers

greater difficulty or promises greater reward than that of determining the nature and arrangement of the constituents of the atom, and the laws which govern their motion. The discoveries already made in this direction have broadened the range of scientific research and advanced our knowledge one step farther into the mysteries of nature; and it is largely the mastery of man over the laws of nature which marks the progress of the world.

The Chemical and Physical Properties of Foundry Irons by J. E. Johnson, jr., which appears in the issues of November 1 and November 15 of **Metalurgical and Chemical Engineering** gives an excellent discussion of the Upton and the Guertler Iron-Carbon Diagrams (G. B. Upton of Sibley College). It shows the relative merits and the usefulness of these diagrams as applied to modern foundry practice.

Johnson lays emphasis on two points: 1. Graphite can separate directly from the melt contrary to the claims of Prof. Howe and Prof. Sauver but in accordance to the common knowledge of furnacemen. 2. After solidification in certain areas of Upton's and Guertler's diagrams a very slight change in conditions may cause a complete change in the resulting products.

He takes up the discussion of the crystal shapes and the form of crystals and illustrates these with numerous microphotographs showing the importance of the shape of the graphite crystals and the form of crystallization in which the iron solidifies. This is followed by a discussion of the results obtained from some recent work by the author at the laboratory of the Ashland Plant of the Lake Superior Iron and Chemical Company which includes the effects of various ratios of carbon silicon, sulphur, phosphorus, oxygen and manganese and their effect on strength, flexibility, freedom from shrinkage and machinability.

Electrical Water Heating in the Household. By J. L. Shroyer, of the Heating Device Engineering Department, General Electric Company, Pittsfield, Mass., **General Electric Review,** October, 1916.

The introduction of the electric range for cooking has led to a wide interest in the use of electrical energy for heating water, making possible the entire elimination of coal and gas from the household. The problem calls for much careful study, since the quantity of energy required is comparatively large.

The instantaneous heater is practically out of the question, since it requires from 6 to 10 K.W. even for small quantities of water, and as high as 40 K.W. for somewhat higher rates of flow. For such high demands for only short periods, and often at times of peak load, very few central stations could offer a rate which would be considered practical.

The best system for general household purposes seems to be the circulation system, in which a tank of water is heated by means of a heating element located in a circulating pipe which discharges the hot water at the top of the tank, where it is available for immediate use. By suitable location of the heater near the bottom of the tank, together with a proper restriction of the rate of circulation, very satisfactory service can be secured from a 600-watt continuous heater, which has the advantage of requiring no attention.

In water containing much scale-forming matter, trouble will be experienced due to the filling up of the storage tank and the circulation pipe. The water circulation is then ended, and the heater usually burns out. To meet this condition, it has been found necessary to design a heater with sufficient outside radiating surface that, no matter if the interior is entirely filled with scale, the heater will not be injured. The scale can be chipped out or may be slowly dissolved with dilute hydrochloric acid.

To avoid overheating the water in the tank, a thermostatic control is most desirable. If the heaters are operated at a flat rate, it saves energy for the central station, and prevents the customer's annoyance at drawing steam from the hot-water faucet when water has not been drawn off for a considerable time.

Some central stations have used time clocks to turn on the water heaters during the off-peak period. While this scheme has proven more or less satisfactory, its value depends entirely upon local conditions.

An item of great importance is the thermal insulation of the water storage tank and connected piping. By this means the capacity of the system is noticeably increased. The efficiency of a 600-watt heater was increased from 27.5 to 92.4 percent by lagging the tank and the circulating pipes with one inch of hairfelt and 85 percent magnesia, respectively. The lagging material must have high thermal resistivity, should be easy to apply, and sanitary, and should be moisture and heat proof as well as non-combustible.

In the article are presented curves showing the results of extensive tests of heaters constructed in various ways, and comparisons are made between the costs of operating gas and electric heaters for various rates for both gas and electricity. It would seem that the electric method is more expensive, but consideration of the better service and lack of attention are in its favor. Flat rates as low as $3.00 per kilowatt-month are being obtained for continuous heaters, which is very favorable, considering the fact that a 600-watt heater seems adequate for an average family. In the matter of first cost, the continuous storage system also has the advantage over the other types. In fact, the advantages of this system to both the central station and the consumer would seem sufficient to confine all future endeavors to this line.

Industrial Multiple Recorder, by R. H. Rogers, Power and Mining Engineering Department, General Electric Company, **General Electric Review,** Oct., 1916.

A device for accurately recording the operation of the various units in an industrial plant has recently been perfected; its novel features are the manner of recording and the simplicity of the apparatus. Briefly stated, the essentials are a clock, a sheet of paper

moving one inch per hour and the recording "pens," which are of fine wire sufficiently heated to scorch lines on the paper when recording data.

The usual system is to make use of magnets which actuate pens using ink, the magnets occupying much room and the pens being unreliable. In this new recorder the tell-tale current makes its own record directly, thereby avoiding moving parts, allowing the use of many "pens" in a narrow space and reducing the cost.

Whenever a recording circuit is closed at some machine or device in the plant a ten mil calorite wire is heated to the scorching point by a current of six volts and one ampere, and a line instantly starts on the paper. When the circuit is broken the tiny wire, having so little thermal capacity, immediately cools and the line ends. Breaks of one minute duration, being one-sixtieth of an inch long, are easily read. The standard sheet is 18 in. wide by 26 in. long ruled into seventy-five spaces, numbered or named to correspond with the apparatus to be recorded and cross-ruled for the hours and quarters. The sheet starts at 9 a. m. and runs 25 hours to allow a margin for changing sheets.

The clock is of a well-known make, weight and pendulum type, guaranteed within 30 seconds per month. The paper feed is simply an auxiliary clock weight which therefore does not retard or interfere in any way with the accuracy of the time-piece.

Additional banks of 75 pens each may be assembled on either side of the clock so that a total of 375 lines may be governed by the one pendulum.

An important feature from the standpoint of the purchaser is the fact that only one wire runs from the instrument to the machine in the factory, all having a common return. No. 18 fixture wire is suitable for the individual leads and the energy may be supplied through a small transformer from a lighting circuit or through a motor-generator set from an exciter or other d-c circuit. The energy applied may be a-c. or d-c. as desired.

A small resistance is inserted in each circuit for regulating the current and consequently the depth of marking, i.e., the total resistance of the circuits is adjusted until they are all alike whether ten or two thousand feet intervene between machine and clock.

There are a variety of contact-making devices available for closing the circuits at the machine or apparatus to be looked after. A simple push button answers for most machinery which is thrown into operation by some lever or similar device; the lever holding the button in contact as long as the machinery is running. For continuity of product, as from a paper machine, cloth printing and the like, a roller mounted on lever arms will complete or break the circuit. Pressure and vacuum systems record through gauges containing contact points; tanks, receptacles or hydraulic heads indicate by means of float actuated switches. Speed of line-shaft or machine above or below normal is recorded by means of a centrifugal switch. Power or lights on and off indicate through a relay. Temperature limits are conveyed by means of thermostat contacts. Thus any item concerning which the management desires running information can be "hooked up" if there is sufficient change in conditions to make or break a circuit.

In practical operation there are three periods of observation:

1st. The running inspection while the sheet is in process of making. The superintendent or manager can see at a glance just how things stand at any moment and can read the general status of the plant as far as the sheet has progressed.

2d. Every morning the sheets for the previous 24 hours are on the desk, tabulated and noted by a clerk to indicate the ratio of possible machine hours to actual machine hours, causes of exceptional stops and such other data as may be of interest. The sheets are in a way a faithful history of the 24-hour period and the trained eye can read the ups and downs of every department and every machine without recourse to more or less inaccurate verbal or written reports.

3d. The sheets acquire great value as comparative reference data after say six months have accumulated. Frequent shut-downs in any spot become conspicuous, absence of trouble in others become equally conspicuous and the causes therefor may be traced to the ultimate good of the whole fabric.

The announcement of **new machinery** in the **American Machinist** for October, indicates that a goodly proportion of the designers are still at work on special purpose machinery largely for the production of munitions and fire arms. Notable among these are the special Gisholt of simple and rigid design, for finish boring, facing and milling the threads of shells, accomplishing in a single handling work which it was customary to do on two machines.

A new size Lo-swing, handling diameters up to ten inches, is a machine of this class, but will also find a place in the motor vehicle shop as well. The design is excellent and well balanced, giving the impression of sturdiness and easy control.

Another development strictly for the shell field is the heavy Boring Lathe of W. & C. Douglass (Middleton, Conn.). It is a single purpose machine in the strictest sense, for boring shells.

The Lombard Governor Company show a machine with radical features for the external operations on six-inch high explosive shells. The control of both machine and tools is through valves operating under oil at a pressure of 200 pounds per square inch.

In the industrial field there are important additions also.

A Herringbone Gear Planer has been developed by the Mesta Machine Company which will correctly cut gears of this type in large diameter. The tool travel control shows excellent design and provides for extreme accuracy in the product.

The Cleveland Milling Machine Company show a new type of Cutter-relieving Machine, of box design that should create a favorable impression.

Economic War and the Machine Building Industries is made the subject of an article by Ludwig W. Schmidt in the **American Machinist** of November 9, 1916, in which the decisions of the allied nations of Europe to form an economic alliance, reached during the so-called Paris Conference, is discussed. This decision is thought to be of wider significance to the machinery trade of the world than at present realized. The neutral nations of Europe exert only a minor influence on the machinery market. Their position, however, is materially strengthened by having the United States in their midst, a machinery producing country of the first class. With peace still far away, but with the possibility of decisive action in the economic field in the immediate future, it is not without interest to know what the machinery industry of Europe has at stake, by venturing into an economic war; also to know what resources each of the countries has at its disposal, both for providing the machines used in its own industries and for building machines for the use of others.

Industrial supremacy is conceded to the Allies. When the war is over at least two countries will have been added to the machine producers in Europe—Russia and Italy. In view of this the position of the neutral machinery producer will become increasing difficult when peace is declared. The United States most likely will feel little of this consequent falling off of business, but the neutrals of Europe have less power to resist and little chance for effective combination. The strength of an economic alliance is pointed out and the belief expressed that after the return of peace the normal economic structure of Europe, woven during many years of peace, and the result of the economic development of centuries, will prove more durable than any alliance formed in the midst of the abnormal conditions of war.

The following comments by the editor of the **American Machinist** in reference to numerous articles appearing in that publication during the past few months are of interest in view of the recent "metric agitation"

Every argument for the metric system has behind it the assumption that the use of the system is to be exclusive—that the old units are to disappear. If the old units are to continue in use, as all experience shows they will, every argument for the system is inverted and becomes an argument against it. Instead of fewer units and ratios we have more of both; instead of better ratios we have worse (those between the English and the metric units); instead of simpler we have more complex calculations; instead of less work for school children we have more; and so on to the end. The metric enthusiast holds up to scorn and ridicule as examples of all that is bad, the ratios 12 in. make 1 ft. and 3 ft. make 1 yd., but he accepts the ratios 25.4 mm. make 1 in. and 3.28083 ft. make 1 m. as steps in the path of progress.

Members of the metric party contrast our tables of weights and measures and their numerous ratios with the metric tables and their uniform ratio of 10, but ignore the tables of metric equivalents with which every engineer's reference book is burdened and which, with the adoption of the system, would become an integral part of the real combined system to be used. If the reader will but turn to those tables and reflect that their equivalents are simply a set of ratios which the adoption of the system will add to those already in use, he will see how the adoption of the system will make matters complex instead of simple.

The universal persistence of old units in so-called metric countries—establishing the fact that the old systems never do die out—is the crux of this subject. The metric party dismisses the overwhelming evidence as of no importance when, as a matter of fact, it not only nullifies and inverts their case, but turns it to ridicule.

As to the men who want the metric system so badly, they seem to be scientists and pseudo-scientists who have use for units of measurement to put down the sizes of things that exist, but not for the dimensions of things to be made.

In recent discussions in the **American Machinist** the fact is brought out that situations will sometimes arise in which definitions of the terms **Gage, Die, Jig, Tool, Fixture,** etc., are called for. While anyone connected with shop production would undoubtedly know how to classify these terms, a difference of opinion might exist as to the proper definitions, as there are no standard definitions of these terms. The following definitions are suggested by one contributor:

Gage—A mechanical device designed to detect variations of measurement in the location of surfaces, holes, projections or other dimensions. Sometimes of an adjustable construction, and when so made should be set to a standard of measurement or by the aid of a measuring instrument. If constructed in such a manner that it will measure the amount of variation detected without the aid of other instruments, it ceases to be a gage and becomes a measuring instrument, which brings it under classification of a tool.

Die—A mechanical device consisting of two or more parts which when brought together in a power-, hand- or foot-operated press, or similar machine, will change or alter the form of hot or cold metals by cutting, forming, bending or causing the metal to flow, or perform any combination of these operations at one time.

Jig—A mechanical device designed to hold parts, or one that can be attached to parts, which in either case has means whereby one or more tools that change or alter the form of the part can be suitably guided.

Fixture—A mechanical device designed to hold parts while manufacturing or inspecting them, and that will hold the parts in the position desired, the guidance of the working tool, if necessary, being accomplished by other means.

Tool—A hand-operated device, machine-tool attachment or measuring instrument that cannot be classified under any of the preceding definitions and that will alter the form or location of parts or assist in their production in any manner.

Steam Turbine Test, by Henry A. Cozzens, Jr., M.E., in the November issue of the **National Engineer,** discusses the use of diagrams for indicating abnormal operation of the steam turbine. The total consumption and water rate curves are very illuminating when studied comparatively. Curves plotted between turbine load and steam pressure in the various stages, one curve for each stage, are of interest in analyzing the action of the steam.

Curves showing the condenser performance are plotted against turbine load and include temperatures of condensate, of cooling water entering and leaving, and the temperature in the vacuum space. These curves should run approximately parallel. If they cross, there is indication of abnormal operation of the condenser.

The operation of the reciprocating engine is studied with the aid of the indicator diagram almost exclusively. For the turbine this is impossible, but the characteristic curves mentioned above will show at once whether the machine is operating properly.

Standards for Electric Service. Circular, No. 56, of the **Bureau of Standards.**

Electric light and power companies are now subject to regulation by State Commissions in more than half of the states of the Union and by municipal ordinance in a number of cities in States not having Commission regulation. The supplying of electric service to the public is a natural monopoly, and regulation on behalf of the public is economically advantageous and necessary.

Owing to the very rapid development and constant changes in methods and apparatus, it has heretofore been very difficult to fix or determine standards for electric service. Developments are, of course, still going on, but the same general methods of electrical distribution, electrical measurement and methods of service are now very commonly used.

The popular movement for the regulation of public utility corporations has spread rapidly since 1907 and at present there are Corporation Commissions, Public Service Commissions or Railroad Commissions in every state save three. In the states of Illinois, Indiana, Montana, New York, New Jersey, New Hampshire, Nevada, Pennsylvania, Oregon, Washington, West Virginia and Wisconsin, orders and rules for the regulation of electrical corporations have been issued by the Commissions. Similar rules are under consideration in several other states, while a few commissions have so far issued only certain recommendations.

Circular No. 56, of the Bureau of Standards, discusses the most important factors constituting and promoting safe and adequate electric service, the circular being based on a careful study of the experience of operating companies and regulating bodies, both state and municipal. The circular contains, first, rules and recommendations for the regulation of electric service companies by State Commissioners; second, three different ordinances suitable for adoption by towns and cities in states not having regulations by Commissions (the first for towns and small cities, the second for cities generally and the third for large cities having an electrical inspector); and third, specifications for the approval of types of electric meters by Commissions.

The rules suggested as suitable for the consideration of State Public Service Commissions, are the result of conferences and correspondence with such commissions, and careful study and comparison of existing orders and rules.

The suggested regulatory ordinances for electric service in cities are based on a very careful study of the subject and conferences with many operating companies and others qualified to express opinions.

Ordinances regulating electric service are so far in force in a very few towns and cities, and in most instances are limited in application to meter inspections and tests. Three different ordinances, varying in scope and length, so as to make them useful in municipalities of all types from small towns to the largest cities, are proposed and discussed.

It is believed these suggested ordinances will be of considerable interest and value to municipal authorities in cities and towns situated in states not having Commission regulations of electric utilities.

A brief description of the electrical testing equipment provided by each State Commission for the calibration and standardization of "working test standards" used by central stations in their meter work, and for making tests on consumers' meters upon complaint to Commissions, is of interest to operating companies, and particularly to Commissions considering the equipment of similar laboratories.

In appendixes are reprinted certain sections of State public service commission laws, relating particularly to the regulations of electric service as to adequacy and safety, and in addition, tables and summaries on various phases of voltage regulation, meter testing, and general central station statistics.

The Bureau asks for criticisms and suggestions from operating companies, commissions, state and city inspectors, committees of associations and engineering societies and all others interested in the establishment of proper standards for electric service.

EDITORIAL

Continued from p. 56

devoted to the carrying on of engineering research and to the printing and distributing of results." The immense good which the passage of this bill would do is self-evident and we would urge all who have the advancement of engineering and of our American colleges at heart, but especially all true Sibleyites, to send letters to their congressmen urging them to work for the passage of this bill.

BOOK REVIEWS

Engineering Applications of Higher Mathematics. By Vladimir Karapetoff. Five Parts. Published by John Wiley & Sons, Inc., New York, N. Y.

Part I. Problems on Machine Design. xiv + 69 pages. 5¼ by 8. Cloth. Price $0.75 net.

Contents: Inclined Plane and Screw; Friction in Journals; Friction in Step Bearings; Carrying capacity of Belts; Torsion of Shafts; Moment of Inertia of Flywheels.

Part II. Problems on Hydraulics. v + 103 pages, 5¼ by 8. Cloth. Price $0.75 net.

Contents: Water Pressure on Submerged Surfaces; Depth of Immersion of Floating Bodies; Time of Discharge of Liquids from Vessels; Form of Liquid Jet; Problems on Water Supply; Best Form of Channel Section.

Part III. Problems on Thermodynamics. v + 113 pages, 5¼ by 8. Cloth. Price $0.75 net.

Contents: Work Done by Expanding a Perfect Gas; Pressure-Temperature Curves of Saturated Steam; Heat of Vaporization and Density of Saturated Steam; Entropy of Gases, Liquids, and Vapors; Heat Transfer in Boilers.

Part IV. Problems on Mechanics of Materials. v + 81 pages, 5¼ by 8. Cloth. $0.75 net.

Contents: Strength of Simple Horizontal Beams; The Elastic Curve of a Beam; Fatigue of Materials; Euler's Theory of Flexure of Long Rods; Flexure of Columns; Strength of Thick Cylinders and Spheres.

Part V. Problems on Electrical Engineering. vii + 65 pages, 5¼ by 8. Cloth. $0.75 net.

Contents: Resistance of Non-Cylindrical Conductors and Magnetic Paths; Minimum Weight of Metal in a Combination of Conductors; Most Economical Size of Conductors; A Leaky Direct-Current Line; Average and Effective Values of Voltages and Currents; Efficiency and Losses in Electrical Machinery.

This set is not a book on Calculus or Analytic Geometry; nor is it one on engineering or any branch of it. These books are intended to enable an engineer to make a better and more extended use of higher mathematics in his work. It is assumed that the reader has once upon a time studied Calculus but allowance is made for the human propensity to forget information. Both Physical and Mathematical Texts are intended to be referred to frequently for the most complete understanding of the problems and methods of solving them. Each volume contains a valuable and complete list of reference works for the field which it covers.

At the beginning of each chapter the physical definitions, and the engineering conditions involved in the topic under discussion together with the necessary mathematical theory are incorporated in a practical exemplary problem so that the reader need not search for information elsewhere. The method of applying higher mathematics is set forth thoroughly and step by step. Then follows an excellent and prolific supply of carefully graded problems with an occasional hint or discussion of the additional physical or mathematical theory involved. Stress is laid more on the method of attack than upon a promiscuous use of formulas. The author's idea conforms with that expressed by the prominent French Engineer Dupuit: "Formulæ are but tools which may guide the intelligence but can never replace it." The whole idea of the work is expressed in the Latin motto in Part II which in plain U. S. means that one can teach better by an example than by abstract precepts.

Each part is independent of the others and may be studied by itself. They will be found very useful (*a*) as a problem book in connection with a regular course in analytics and calculus; (*b*) as a textbook in a supplementary course in mathematics; (*c*) as a textbook in a course in Engineering Mathematics; (*d*) as a reference book in a seminar for graduate students; (*e*) as a study book for teachers and for practicing engineers who feel that they need a "brushing up"; and (*f*) as a book for home or summer study by the ordinary college student.

The collection of suitable problems involving calculus and covering the various branches of engineering, no doubt took a vast amount of time and labor. The author deserves the gratitude of the engineering profession and of the teachers of mathematics as well as of the student who endeavors to master engineering mathematics, for his simple and thorough treatment of the subject.

UNIVERSITY NOTES

Fifty members of the senior class in Sibley College have this year elected to take the new optional course which was started last year entitled "Industrial Engineering." This enrollment is an increase of five over that of last year. The main purpose of this senior option is to prepare the engineer more in detail for handling the commercial problems with which he may have to contend in the various branches of practical engineering. In addition to a lecture course and drafting troom work, it includes several courses in economics and allied subjects.

Mr. C. F. Roland, New York representative of the National Tube Company, delivered a very instructive and interesting lecture entitled, "From Ore to Finished 'National' Pipe," in Sibley Dome on November 9th. His talk was illustrated with motion pictures which clearly showed the various operations necessary in the manufacture of wrought iron and steel pipe from start to finish. The National Tube Company are the largest manufacturers of pipe in the world and their plants are equipped with the most up-to-date machinery thus enabling them to turn out over 2,000,000 tons of pipe a year.

PERSONALS

Rolla C. Carpenter, M.M.E, '88, Professor of Experimental Engineering in Sibley College, and **William H. Boehm, M.M.E., '93,** are both members of the Boiler Code Committee of the A. S. M. E.

Karl E. Battey, '15, has been sent to Atlanta, Ga., by the Pierce-Arrow Motor Car Company to take charge of the service work of their agents, John M. Smith Company, whose territory embraces North and South Carolina, Georgia, and Florida.

James Francis Barker, '93, has resigned as principal of the Eastern Technical High School of Cleveland, Ohio, to accept a position as head of the Mechanics' Institute of Rochester, N. Y. The Mechanics' Institute has a staff of about seventy instructors for two thousand students.

Frederick C. Fabel, x'97, is superintendent of the American Oak Leather Company, of Cincinnati. His address is 2484 Observatory Avenue.

William H. Thomson, jr., '98, is located temporarily in St. Louis, having resigned as general manager of the Kansas City Electric Light Company.

John H. Wynne, '98, who is with the American Locomotive Company, has changed his address from Westmount, Quebec, to Arch Road, Englewood, N. J.

C. E. Breckenridge,' 00, has resigned his office of assistant chief engineer of the Aetna Explosives Company, Inc., to accept a position as chief engineer for Merck & Company, with headquarters in Rahway, N. J.

Robert H. Hazeltine, '00, has changed his address to 251 West Eighty-eighth Street, New York City.

Henry R. Cobleigh, '01, formerly mechanical editor of *The Iron Age*, and of late managing editor of *Power*, has established himself in business as a partner in the Power Management Company, National Bank of Commerce Building, New York.

Charles A. Kelsey, '01, an engineer with the General Electric Company, was in Cuba during April and May, 1915 for that company, in connection with the electrification of some sugar mills. He is a member of the A. I. E. E.

Reginold Trautschold, '02, who has specialized in the power plant field for a number of years, is the winner of the second prize of twenty-five dollars offered by the Diamond Power Specialty Company for the best papers on mechanical soot blowers.

A. Penn Denton,'04, is the happy father of a daughter, Saradora, who was born September 1st, 1916.

F. W. Poate, '04, who, when in college, was a member of the varsity track and cross country teams, is a lieutenant in the British motor machine gun service, and has been on the Somme front in France since July. He writes to a friend in this country: "I have been gassed and shelled and crumped and had a machine gun playing on my car when I was stuck in a hole and couldn't get out, so I have had a fairly varied experience of modern warfare, but I haven't found anything yet up to the strain on one's nerves when waiting for your race to be called! * * * I dare say you have heard of our latest—the "Tanks"? They are a part of my own service, so I know all about them—been on board them. They are most extraordinary things; very useful, too."

Barrett Smith, '04, technical advertising engineer of Boston, has extended his practice in this territory and the middle west to such an extent that he must spend part of his time at 65 Duane Street, New York. Mr. Smith specializes in the advertising of structural products and machinery more particularly in connection with large construction projects, the trade literature which he has produced covering many of the well-known developments of recent years. He was appointed by Stone & Webster and the Massachusetts Institute of Technology to manage the electrical division of the recent industrial exhibition held in connection with the dedication of the New Technology buildings at Cambridge.

Harry Lee Ames, '07, of Painter, Va., welcomed the birth of a daughter on the first of August, 1916.

Continued on page 7 Adv. Section

EMPLOYMENT NOTES

261. S. D. Leland, President, Manufacturing Equipment and Engineering Company, Framingham, Mass., wants man for engineering department, for drafting and "general work necessary to put goods into factory for manufacture". (Metal lockers, tables, chairs, etc.).

263. W. D. Wood, Mechanical Engineer, Fuel Department, Fuller Engineering Company, Allentown, Pa., wants man with two to four years' experience in locomotive or railroad machine shop. Prefers man with some experience in locomotive road testing. Salary $125, and expenses when on the road.

264. Mr. H. Schefflin, Manager, Crushing and Machinery Department, Allis-Chalmers Manufacturing Company, Milwaukee, wants recent graduates to enter a two-year graduate student course in preparation for following the cement and crushing business in which there are excellent opportunities.

Continued on page 9 Adv. Section

PROFESSIONAL DIRECTORY

PERSONALS

Continued from page 86

John H. Raidabaugh, '05, has opened an office, in conjunction with F. G. Fahnestock, jr., an architect, in Rooms 401–402 Patriot Building, Harrisburg, Pa., for the practice of architectural and engineering work.

J. M. Fried, '07, and Mrs. Fried, of Vicksburg, Miss., announce the birth of a son, born on October 24, to whom they have given the name Saul.

B. Mason Hill, '07, is an electrical contractor in Petersburg, Va.

George H. Cunningham, '08, has resigned his position as superintendent of construction with the Anaconda Mining Company and accepted the position of chief engineer for the Electrolytic Zinc Company of Australia, with headquarters at Hobart, Tasmania.

Frederick O. Ebeling, '09, formerly engineer and draftsman for the Robins Conveying Belt Company, New York, has become associated with the Gifford-Wood Company, Hudson, N. Y., as sales engineer.

Hans C. Boos, '10, was married to Miss Ella Aralee Graybill, daughter of Major (C. S. A.) and Mrs. James Edward Graybill of New York, on June 21, 1916. Mr. and Mrs. Boos are living at 1905 Andrews Ave., New York. Boos is with The Curtainless Shower Company of New York and Chicago as stockholder and sales manager, he having discontinued his patent and engineering practice in March, 1916. The company manufactures the "Kenney Needle Shower."

Continued on page 8 Adv. Section

William Wilke, jr., '09, is a chemical engineer. His address is 28 Detroit Street, Hammond, Indiana.

Robert W. Canfield, '10, and Caroline Merry Canfield, of East Orange, N. J., welcomed the arrival of a daughter on June 30, 1916. Canfield is now with the General Electric Company at Newark, N. J.

J. Birchard Green, '10, is president of the Chicago Steel & Wire Company, 1123–1129 West Thirty-seventh Street, Chicago. This firm manufactures stitching wires.

T. Lee Miller, '10, formerly sales manager of the Sangamo Electric Company of New York, has become vice-president of the Fort Wayne and Northern Indiana Traction Company. His address is 702 West Wayne Street, Fort Wayne, Ind.

F. H. Best, '11, is connected with the American Telegraph & Telephone Company in New York City.

C. S. Coler, '11, is manager of the Casino Technical Night School, and is secretary of the Grievance Committee of the Westinghouse Electric and Manufacturing Company. His address is 404 Biddle Ave., Wilkinsburg, Pa.

Francis E. Finch, '11, was married to Miss Dorothy Homan Corwin, daughter of Dr. and Mrs. Ferd Miller Corwin, at Bayonne, N. J., on September 30.

C. Kenneth Getchell, '11, has been transferred from the Schenectady office of the American Locomotive Company to the engineering department of the Company's New York office, at 30 Church Street. He is living at 38 Garden Place, Brooklyn, N. Y.

Albert W. Grant, jr., '11, who was formerly identified with the photometrical department of the United States Improvement Company, Philadelphia, is now with the H. Koppers Company of Pittsburgh, Pa.

William Haag, '11, is with the New York Central Railroad Company in the motive power department, Room 32, Union Station, Albany, N. Y.

S. B. Kent, '11, is working in the engineering department of the Western Electric Company in New York City.

William H. Reid, '11, was married to Miss Florence Isabelle Reid of New York City in June. Reid and his wife are now in Barcelona, Spain, where Mr. Reid is employed by the American Locomotive Company. He should be addressed in care of Thomas Cook & Sons, Barcelona, Spain.

Herbert B. Reynolds, '11, M.M.E., '15, has changed his address to 149 North Broadway, Yonkers, N. Y. He is assistant engineer in the M. P. Department of the Interborough Rapid Transit Company.

David R. Swinton, '11, formerly sales engineer for the Tuthill Spring Company of Chicago, has accepted a position with the Perfection Spring Company, Cleveland, Ohio.

L. L. Porter, '12, who is in Karachi, India, for the Standard Oil Company, has returned to work after a six weeks' vacation in Kashmir. He is planning to return to this country in 1918 for several months.

Lloyd M. Church, '13, was married to Miss Pauline Huff, of Rochester, N. Y., on September 23, 1916.

EMPLOYMENT NOTES

Continued from page 86

265. Mr. Dana D. Barnum, President and General manager, Worcester Gas Light Company, Worcester, Mass., wants two cadet engineers in connection with their new generating and by-product coal-gas plant.

266. Mr. R. E. Hopkins, '12, of the Ingersoll-Rand Company, Painted Post, N. Y., wants recent graduates for production work, engineering, inspection and sales.

267. C. W. Davis, Vice-President, Standard Underground Cable Company, Westinghouse Building, Pittsburgh, Pa., wants several recent graduates for testing cables, etc., in the Production Department. Also recent graduates for research laboratory.

268. Mr. R. C. Folger, '08, Aluminum Company of America, Massena, N. Y., wants M.E. or C.E. as assistant to engineer in charge of repair and maintenance. M.E. with knowledge of surveying and civil engineering practice or C.E. with knowledge of machinery.

269. Mr. P. L. Thomson, Advertising Manager, Western Electric Company, 195 Broadway, New York City, wants recent graduate interested in advertising work, and with taste for writing. Man selected would be given six months course at Hawthorne (Ill.) works.

270. W. H. Cooper, Carter Oil Company, Sistersville, W. Va., wants young man with some experience in mechanical drawing, who would like to learn the gasoline business. Also wants a draftsman to work into the business.

271. Mr. E. P. Ford, The Duratex Company, Newark, N. J., has an opening for a man who has had three or four years' experience in handling steam plant and machinery. "Very good opening with a chance to grow."

272. Mr. W. G. Hudson, Vice-President, Guarantee Construction Company, 140 Cedar Street, New York City, wants draftsmen with experience in coal handling machinery, structural steel work or reinforced concrete design.

275. W. P. Paxton, secretary Southern Textile Machinery Company, Paducah, Ky., wants men with theoretical knowledge of metallurgy, tempering, drawing and working of metals; also some practical experience preferred. "Believe we can show very good prospects for his future."

279. U. S. Civil Service Examination, December 13; No. 1547 for assistant engineer inspector of Weights and Measures in Bureau of Standards, $1000 to $1600; No. 1625 for structural engineer and draftsman (supervising architect's office, Treasury Department) $1600 to $1800; No. 1629 Laboratory apprentice, Bureau of Standards, $480–$540. Write to C. S. Commission, Washington, D. C. for form 1312 and state title of the examination.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI JANUARY, 1917 No. 4

Published by
THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.
Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:
United States, Mexico and Canada, $2.00 a year
Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR JANUARY, 1917

Engineering Abstracts

Engineering is advancing so rapidly and the field which it covers is becoming so broad that one can not keep in close touch with the progress of the times even though he devote his entire time and attention to this task. Yet it is quite important for the progressive engineer to know what his contemporaries are accomplishing and what is being done in the engineering field in general. To give its readers a birds'-eye view of the most important developments in pure and applied science, THE JOURNAL has started a department devoted to Engineering Abstracts. In this, so far as is practicable, we hope to include a summary of the most important articles appearing in the best engineering publications in this country and abroad. Most of the professors in Sibley College have consented to abstract one or more magazines covering their line of work. It would be difficult to find a more competent or more expert group of men to judge the merits of articles and to condense them to the form that is most useful. Thus our readers, spending an hour or so each month, can obtain in a nutshell a good survey of the current periodical literature relating to engineering. In case the original articles are wanted, THE JOURNAL can in most cases furnish its subscribers with the magazine in question at cost prices. Any suggestions aiming to increase the utility of this column will be greatly appreciated by the editors.

Over-Specialization

In this age of specialization, it quite frequently happens that the object in view is thwarted by going to extremes. An investigator who is not aware of the danger of over-specialization, is quite likely to devote an undue proportion of his time to a particular problem which interests him. In his eagerness to investigate one field he looses sight of the whole remaining domain of science and engineering with the consequence that he places an artificial barrier between his results and those of his contemporaries; he destroys the connecting link.

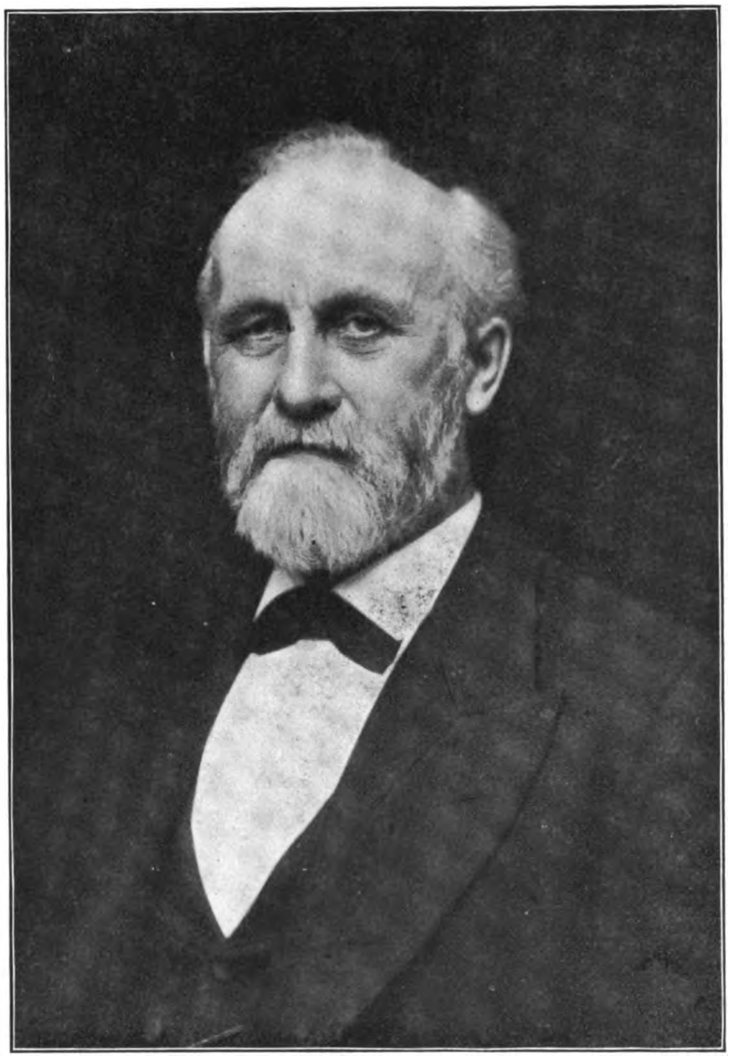
This tendency has been more pronounced perhaps in the natural sciences than in engineering. A chemist is so engrossed in his test-tubes, filter papers, and colloids that when he encounters a problem involving physics or geology he generally side-steps it because he feels that it would be a waste of time and energy to investigate side issues. While the practical sense of the engineer prevents him from falling deeply into this erroneous attitude, it is nevertheless, frequently unable to free him entirely. Hence the trained scientist too

Continued on page 100

REMINISCENCES AND CHARACTERISTICS OF PROF. JOHN E. SWEET

By J. E. JOHNSON*

An extremely interesting, elevating and well written account of the life and character of Prof. John E. Sweet was prepared for *The American Machinist* by J. E. Johnson, Jr., Cornell, M.M.E. '92, and appeared in their issues of Nov. 16 and 23. Owing to the fact that Prof. Sweet was such a vital force in fashioning the Engineering Course in the early days of Sibley College and in molding the characters of so many of its best teachers and graduates, and due to the splendid portrayal we here reproduce rather fully the articles as they appeared in *The American Machinist.*



In the opening paragraphs Mr. Johnson shows that Prof. Sweet was greater than the material records show, that his character was more than his achievements, and his being surpassed his doing. He then continues as follows:

Professor Sweet's life as a whole, may properly be divided into two portions—that previous to his becoming professor of mechanical arts at Cornell, and the portion subsequent to that important event.

Owing to the urging of some of us, Professor Sweet prepared within quite recent years an outline of an auto-biography. This has the defect that Professor's incurable modesty did not permit him to put the emphasis upon the important things of his life, or even to describe them fully. Nevertheless, it is the best information we have in regard to his early life and is quoted here almost in full:

PERSONAL REMINISCENCES WRITTEN BY PROFESSOR SWEET

I was born in Pompey, and Pompey was a good place to come from, because a good many pretty good people have come from there: Horatio Seymour, who ran for President; Grace Greenwood, the author of "Fifty Years Ago"; Charles Mason, patent commissioner; and later, Holland Duell, also commissioner; William Avery, the inventor of the Avery engine and many other useful inventions; besides many other noted people.

Pompey generated some comedians and liars—one man who had two yoke of oxen drawing interest, and a liar who could give Baron Munchausen hearts and spades and beat him on inventing stories. As an example, he built himself a log house and it was so tight that the fire would not draw, so he bored a gimlet hole through the sash and it was all right. Old Strickland had a wonderful dog that could run like streaked lightning. It was chasing a fox, and the fox swerved past a sapling. The dog, always aiming for the fox, struck his nose squarely against the sapling, which split him from end to end; and as the two halves passed the sapling, they came together and welded, and the dog kept on and captured the fox.

The thing that I remember that dates back the farthest must have been when I was perhaps three years old. I had my knee on a stick across my little chair, trying to saw the stick with a compass saw. My father said, "That boy will make a mechanic." That I remember as distinctly as I do anything that happened yesterday. How near that prophecy came true, others may guess.

I believe the next event that I call to mind was when I was four years old. Our people moved to a farm at Britain Settlement, now Collamer, north of Messina

*Consulting Engineer and Metallurgist.

Springs. I only remember that Jim Terwilliger (I remember him particularly, as he challenged my first vote) attended the same country school, but not long, as I do not think I went over two days.

When we were returning to the Pompey farm, we stopped at Messina Springs Hotel. My mother was taken sick and asked my father to get her some wine, and I was horror-stricken. It would seem from this incident that I inherited my temperance notions. I don't know what became of me from that time until I was seven years old, probably nothing, for when I was four years old my youngest sister was born and from that time until I went to school I existed and kept out of the way. I was always tinkering and was dubbed "Johnny Tinker."

I don't remember about my great achievements during my school life, as that was mostly in the old stone schoolhouse. I cannot remember that I ever studied—not that I was the bad boy in the school or out, or made any trouble, as I was never punished or had a fight. My best hold was in arithmetic and geography, the latter because I could draw the maps better than the others, and the arithmetic was easy for me. There were three schoolhouses, each a mile and a half away, and it was getting an education at long range. My last teacher was a Miss Bridgman, who found out my weak points in schoolwork when the study of grammar came up, for I got no farther than the one rule, "A noun is the name of something." When she attempted to start me on algebra she said, "Let *A* stand for 300," or something of that sort. I asked why three and two naughts wouldn't do just as well. She then gave it up as a bad job.

BEGINNING OF MY MECHANICAL EXPERIENCE

My mechanical experience started simultaneously with my schoolwork, as the first day was only a half-day in school. I went home at noon, and in the afternoon I made a model of a plow. With one of my left-hand improvements, I made the moldboard very long and explained to my brother that I made it that way because it would draw easier. So, my mechanism began to show itself early, as did my disposition to do things better. I cannot call to mind ever starting on a job without thinking out how to make it better than it had been done before.

When I was about twelve years old I made a small fiddle. My parents likely thought I made the fiddle because I wanted to play it, so I was sent over to Mr. Sutherland's to take lessons and came home at the end of two weeks with about a dozen tunes to my credit, which would indicate that I was an apt scholar. Perhaps I was, in a way, but no musician, as I did not learn how to tune my fiddle for twenty or thirty years, and then not as musicians tune theirs. I make a distinction between a fiddler and a musician: The fiddler plays one note at once and the musician two, and when I learned to tune my fiddle it was in a new way. When the string of a stringed instrument is slightly touched in its middle, both halves vibrate alike, and the result is a harmonic; if touched at a point one-third of its length, it divides into three parts and all three vibrate, making a harmonic of a higher key. This harmonic on the A string is the same when the instrument is in tune as the first harmonic on the E string, so I discovered that I could tune the instrument by bringing these two together. I could tell when the two notes were at the same pitch, but never could tell when two notes of different pitch harmonized.

It was during this period of my life that I first began my graphic method of solving problems. I had noticed the unequal spacing of the frets of a guitar and learned from Mr. Sutherland that the true A sharp and B flat were not the same, but that in a guitar, piano, etc., the same note was used. He said, too, that the violin and trombone were the only true instruments, as by those the true flats and sharps could be produced. I devised a graphic method to lay out the frets, making the best compromise for all keys. I made a guitar and so placed the frets, and Mr. Sutherland said it was the best guitar he had ever seen. Likely the way the standard instruments are made is the best for some one key—C perhaps—and worse for some other.

About these days our people had a stone cistern made and the masons were two of the Fargoes. The founder of the express business was one, and he appeared a little too well dressed for a mason; but when my mother mentioned it, he said he would never wear poorer, and during his later life he didn't have to.

MY FIRST LESSON IN MECHANISM

I distinctly remember my first lesson in moving mechanisms. In those days our grain was at first threshed by a complete horsepower machine erected in our barn, and later by the portable machine that circulated during the fall from farm to farm. In the case of the latter the horses and gearing operated outside the barn, and a belt conveyed the power to the machine in the barn. I told one of my brothers that I couldn't see why the cylinder of the machine went faster than the band-wheel of the power, as certainly one end of the belt could not travel any faster than the other. I expect he set me right, and it is mighty few times I have ever had to be set right in that respect.

I was always at making something, had a turning lathe in the second story of our horse barn. It was turned by a crank, and my sister-in-law used to climb the stairs and turn the crank. We had, in the years of my idle life, a good deal of building and repair work in which I took a hand, and this led to my going, on the first of April, 1850, to learn the carpenter's trade. I worked seven months as an apprentice, for $7 a month. This money went for tools and board at $2 a week here in Syracuse, when I began to spend my money to the best advantage. By the favor of a neighbor living here, he got me the opportunity to build the fires and sweep the office of Deacon Hayden, who was then the only architect in the city, so then from the early winter till carpenter time in the spring I was learning something

about drawing and architecture as that existed at that day.

At that period of my life I was fortunate to become associated with two of the best men possible, John Pinkerton and Deacon Hayden. The first week of my apprenticeship I helped make two planes, one of which I still possess.

My mechanical life ran into architecture, and there are a number of buildings in this city from my designs, and my architectural career ended at the breaking out of the Rebellion, when I was building from my own design at Selma, Ala., a hotel that would have been the second-best hotel in the South. It was stopped, and the plans were destroyed during the Rebellion. I was called down there afterward to make the plans over, and now, as a monument, I should not be ashamed of it if erected in this city.

MY FIRST VISIT TO EUROPE

After returning from the South, where I left one rainy day, I became acquainted with William B. Cogswell, who was a partner with my brothers. He left there for the Central R. R. shops and from there took a position in the Government shop at Port Royal. I took his place at the railroad shop and completed the drawings in detail for locomotive No. 108. The Government at the seat of war at that time was giving jobs to those who wanted to stand up and be shot at, which was a job that I did not hanker for. Besides, I had cultivated a desire to see Venice and other cities, and so, early in 1862, I went to the London Exhibition of that year, and from there to Paris, Switzerland and Italy, as far as Rome.

A good deal of this trip was alone and, remember, traveling fifty years ago alone in foreign countries was not the simple job it would be now. There were events along the journey worthy of notice; but I can only mention a few. In going over the St. Gothard Pass it was in a two-horse box, with four of us jammed inside with our limbs ship-lapped together—two Russian women, a German and myself. It was a jolly party. We were allowed to disembark at the Devil's Bridge, where the noise of the boiling water was so deafening that it would not have made any difference what language we spoke; nothing could have been understood. It took all night to get over to Como, and from there we went by train to Milan. During the night on the mountain, we stopped at the hospice, where we exchanged money for bread.

From Milan to Venice, then a half-day's journey, we went over the line to that part of Italy that was then under Austrian rule, through the forts and battlefields, through Verona and into Venice, which was one of the scary times of my life. It was midnight, and instead of getting into the gondola omnibus two gondoliers got me in a single gondola and made a short-cut of a couple of miles or so through the narrow, dark canals to the hotel. It makes me shudder now, fifty years later, to think of it. Venice was a gem to me, and it has grown brighter and brighter each of the three or four times I have seen it since.

SOME INCIDENTS OF THE VISIT

On a Saturday afternoon I went with a gondola-omnibus load out to the Adriatic bathing ground. A young gentleman, recognizing me as an American, came over and started an acquaintance. He asked me to come and take dinner with him Sunday. It turned out to be William Dean Howells, then consul at Venice, and later one of America's greatest authors. On Sunday evening, while in the depot to leave fcr Florence, another gentleman made himself known to me. He proved to be the general agent of the Wheeler & Wilson Sewing Machine Co. We traveled together until we returned to Paris.

Through Florence, Pisa and Rome I made myself so conversant with the make-up of all the sights that when I visited them fifty years later it seemed to me as easy to travel there as in our own cities. I will not bother to enumerate the various sights further than to mention St. Peter's, the Coliseum, Pantheon, the Capitoline Hill and Museum, Trajan's Forum, St. Paul's outside the Gates, the Pincian Hill, the Museum, the Vatican, the statue of Moses and that of Pauline Borghese. At the visit fifty years later, about the only notable addition was the statue of Garibaldi. In the thirty-six hour return trip from Civita Vecchia to Marseilles I learned what it was to be seasick for thirty-five hours.

EXPERIENCES IN LONDON

After returning to London, where I first saw Dickens, I secured a position as draftsman in the International Patent Office, a big name for two of us—Dr. Hazeltine as the company, and I assistant. It was pretty hard sledding sometimes. I got a job one time making the patent drawings of a machine for making envelopes, and the last dinner before I got my pay was made out of a halfpenny loaf of bread eaten beneath a railway arch—a halfpenny loaf is *not* the best bread made in England. My first knowledge of Charles T. Porter [of Porter Allen engine fame] was in making the patent drawings for the Richards indicator for him. At that time patent documents, including the drawings, were all on parchment.

I had invented a nail machine to make two nails where one was made before, and at Mr. Hazeltine's instigation I took out an English patent. He interested the proprietor of the Patent Nut & Bolt Co. to undertake the construction and introduction of my machine at its works at Smethwick, near Birmingham, and there I spent the remainder of the two years I was away in making two or three machines and in trying to make them go. Returning home, where I had sent the drawings, I found that a machine was being made from improved drawings, and the patent attorney had taken an interest. When the machine (which didn't work any better than the English one) was done, we went with it to New York as joint owners. The attorney sold out my half of the patent to some of the sewing-machine men for $10,000. Eventually he got half of it and two or three years at a good salary to make two or three more machines that didn't work, either.

Out of the money I built another machine and exhibited it at the Paris Exhibition of 1867, where I saw Napoleon III and his wife, the Empress Eugénie, one of the most noble and beautiful women I ever saw; King William, who later became Kaiser William I of Germany; Bismarck and other notables; the kings of Austria, Spain, Portugal; the shah of Persia; khedives of Egypt and Turkey; and the Prince of Wales, who later became King Edward VII and father of the present King George V. Later, at the Centennial, I saw Don Pedro, ruler of Brazil, and had the honor of meeting the King of Belgium in Brussels; that is, he was going one way in the street and I was going the other.

A MACHINE TO SUPERSEDE MOVABLE TYPE

The machine I invented is in the museum at Cornell, a relic now, but a masterpiece of ingenuity and workmanship executed by William H. Craig, a master mechanic. It was an attempt to supersede movable type and was the forerunner of the linotype.

For a time I was superintendent for Whitman & Barnes, then at bridge building for Howard Soule—the man I used to say I had as lief carry my pocket-book as to carry it myself. While building a bridge at Ithaca, President White and Mr. Cornell came around one afternoon and asked me to meet the Cornell Board, which I did and talked over what to do in the Sibley shop. This was soon after building the first Straight-Line engine, and some months after this I was engaged to take charge of the Cornell shop.

The engine was purely an experimental one. Almost every element differed from common practice. The frame was straight instead of crooked; the cylinder had a jacket cast around it; the piston had a length equal to the diameter; the piston rod was ground round and straight and ran through a reamed bush; the crank between two flywheels; the valve a mechanically fitted balanced valve; engine resting on three points; end play to shaft and crank bearings; and many other features. Explaining this and the notion of making perfectly flat plates and straight-edges and a measuring machine, etc., and suggesting these things in the shop are probably what got me the position, and doing these things is what kept it. We speak of the engine as an invention, while, in fact, the engine in its various forms and the different devices devised for its manufacture likely would foot up to nearer a hundred than one.

WORK IN THE CORNELL SHOPS

At Cornell we were constantly developing new things—absolutely perfect surface plates, straight-edges, squares and angles, standard gages by the use of the measuring machine (which we built, the first ever built in this country, and which read to the ten-thousandth of an inch and enabled us to judge to the forty-thousandth of an inch). Visitors to the university were always shown our shop, and the wonders of the work we were doing interested the greatest of them all. Mr. Cornell was a constant, interested visitor while he lived; General Grant, Henry Ward Beecher, John Hay and hundreds of others came. In conversation with Henry Ward Beecher I casually remarked that an ordinary college graduate was of not much use in a machine shop, and he said he guessed I had never seen one in a pulpit.

Measuring hairs was one of the things to show off. The fact that all the hairs of one's head are of the same size was a discovery, and the various sizes was another. Every hair of my head, and I measured hundreds, is twenty-four ten-thousandths of an inch, and the finest one I ever measured was fifteen ten-thousandths. I remember one incident: We built certain lathes, and among other new things all the bolts and nuts that had to be changed to meet conditions were made to be operated by the one wrench. Showing it off to a friend, he said, "What in the world would you do if you lost that wrench?"

FOUNDING THE STRAIGHT-LINE ENGINE CO.

The best thing we made, or helped make, at Sibley, I suppose—or hope, at least—was a lot of valuable men. A train of circumstances compelled me to abandon my post, a lamentable thing for both, I think. I returned here, remodeled the engine and made it so good that five of us put in a thousand dollars each and organized the Straight-Line Engine Co. With the aid of a company of able and devoted assistants we built up during the third of a century a moderate business and an extra good reputation. During the life and death of the engine business four of the five founders—David Hotchkiss, George Barnes, Anson A. Sweet and Henry Stevens—have died; and by the combined elements of gas engines, electric motors and other and more profitable business for the shop the engine business has died.

A few months before the Chicago's World Fair, where I spent six months as a judge, I designed a steam separator; and at the instigation of some of our associates the separator was patented and the Direct Separator Co. organized. At first it seemed like the tail of the Straight-Line Engine dog, and later it looked as if the tail was going to wag the dog. Anyway, under the management of some of the engine company's lieutenants it has prospered wonderfully.

Some three or four years ago the manufacturers in the city joined in building a trade school. While it had to be abandoned, it was not because of any fault of the plan. It was undertaken because of my advocating it, so it naturally fell to my lot to father it; and the cause of the failure was my age. I was twenty-five years too old when the school was started, and it was wearing me out. It is lamentable that the engine business failed, and it is far more lamentable that the school failed.

Such are the little events of my life, because there were no big ones. I have never been drowned, burned to death, shot or dynamited; in fact, I have never been killed, in jail, arrested or sued. Likely the most important thing I have done was to set the ball rolling for the organization of the American Society of Mechanical Engineers, of which there are between four and five thousand members scattered throughout the inhabited

surface of the world; that which is the most pleasing is the annual meeting of my "boys", who gather to honor me on my birthday, and have for a dozen years. A year ago the American Society of Mechanical Engineers, through a committee, made a great splurge, and in the large assembly room seated 250 to honor my eightieth birthday. It was a great occasion and a great honor.

I have traveled a good deal, likely nearer two hundred thousand miles than one, and never met with but one accident. That was from jumping out of a buggy when ordered out by the driver. I struck on my head, which knocked me out for a couple of hours and knocked my eyes out of focus. I have crossed the Atlantic fifteen times, have been in ten seas and twenty-two countries.

I have recently been honored by the degree of doctor of engineering. In response to the committee I said I could not understand how I deserved it, and I see no way to justify it, except to use the remaining years of my life in inventing a way to get electricity direct from the coal, or a way to burn the coal in the mines.

Professor Sweet's Boys

As to the portion of Professor's life during and subsequent to the Cornell days we have the recollections of "Professor Sweet's boys." Perhaps it will be as well to give here a brief description of the loose organization to whose members this term was applied.

It was perhaps the most significant phase of Professor Sweet's character that men once thrown in contact with him, even if not very intimately, retained a vivid recollection of him and a desire for more of his companionship. This was partly because of his personal charm and partly because of the generosity with which he gave himself, to whoever might ask of him, without any question of the right of the person asking the favor, but simply on the ground that that person asked his assistance.

In the early autumn of 1901 I received a letter from E. J. Armstrong, superintendent of the Ball Engine Co., who had at one time been superintendent of the Straight-Line. He asked me what I thought of the project of getting together as many as we could of the old boys for a dinner in Professor's honor and of making some sort of presentation to him to show our affection for him. I responded enthusiastically and so, I think, did all the others to whom Mr. Armstrong wrote. No organization was formed, except a dinner committee, and Mr. Armstrong did practically all the work as secretary of that. Mrs. Sweet was taken into our confidence, but the matter was kept entirely from Professor's knowledge. Fortunately for our plans, he and Mrs. Sweet took a long trip to Mexico during that fall and returned only a short time before the date set for the dinner.

In casting around for something to present, one or two suggested a watch. Mr. Armstrong wrote that as the one Professor already had, which had a rubber case, "fell apart whenever he opened it, and his eyes were getting too poor for rapid reassembling," it was decided that a watch would be most suitable. The trouble was that a watch is jewelry, and Professor with his extreme simplicity of taste would not like and probably would not use a watch of the ordinary character. At the same time he had often expressed his admiration for the wonderful works made by Jurgensen. He also admired very greatly the black finish on iron made by the Bauer Barff process. Accordingly, a set of Jurgensen works was procured and a special case made of Bauer Barffed iron, bearing on the cover a bas relief in gold of the first Straight-Line engine. The project was financed by voluntary subscriptions from the "boys."

THE FIRST SWEET DINNER

The date chosen for the dinner was one of the evenings during the latter part of the week of the New York meeting of the American Society of Mechanical Engineers in December, 1901. The dinner was held at the old "Arena." Professor had planned to go back to Syracuse the afternoon of the day for which the dinner was set, but Mrs. Sweet discouraged the idea and Mr. Armstrong persuaded him to stay over to help "talk to some men to whom he (Armstrong) wanted to sell an engine." We all gathered in a reception room, adjacent to the dining room, at an early hour, and Armstrong then brought in Professor to meet the men who were "to buy the engine." His surprise and delight in meeting again these men, many of whom he had not seen for twenty years or more, was something that will always be one of the pleasant recollections of my life. He went around the room greeting each one in turn with equal delight, but with varying degrees of surprise in the different cases. One man, not interested in engineering and whom Professor had not seen for nearly twenty-five years, came all the way from Cleveland to attend the dinner. After the greetings were over, we adjourned to the dining room, where the dinner was served. In deference to Professor's strong temperance convictions no wines or liquors of any kind were served, and I think that no one even smoked, but at the later meetings Professor insisted upon providing the cigars himself.

Albert W. Smith, then Dean of Leland Stanford University and now Dean of Sibley College, presided. No outside talent in the way of speakers was called in; a half-dozen or so of the "boys" had been given subjects and were called upon. Engineers are not always good speakers, but perhaps because in this case what they had to say came straight from their hearts, I think I have never heard speeches of such a high order of real excellence and suitability for the occasion as those were. The lamented John A. Hill was there, on account of Professor's long association with *The American Machinist*, and made a rattling speech, one or two sentences of which have always remained in my memory. One of them was that he believed "in holding the wake while the corpse was still alive and could have part of the fun," a fact we too often forget.

None of the speakers made the slightest allusion to any feature of the dinner except the reunion, until the last one, F. A. Halsey, now editor emeritus of *The American Machinist*. At the conclusion of a few well-chosen

sentences Mr. Halsey drew from his pocket the case containing the watch and presented it to Professor "as a token of our affection and esteem." The old gentleman had been having as much fun as anybody out of the proceedings, but that was too much for him. He arose to his feet with the tears streaming down his cheeks and said, "Gentlemen, I had expected to make a few remarks but I cannot," and sat down. We sat around and talked to a late hour, and it was unanimously voted that the meeting was such a great success that we should hold one every year, and this was accordingly done.

OTHER DINNERS OF "PROFESSOR SWEET'S BOYS"

Every year, with the exception of 1911, when Professor was on a trip around the world, a fair-sized company of "the boys" met at dinner to do him honor. Once we had only eight or ten, but at most of the gatherings there were from fifteen to twenty-five or thirty. Considering that there were only about fifty on the whole list and that some of these were so far away or so circumstanced that they could never come, it will be seen that the percentage of the attendance compared with any other similar annual dinner was very high. In a good many instances men came a thousand miles or more simply for this dinner, and in one case a man came from Denver and in another from San Francisco. Considering that these gatherings were only informal affairs and that the sole attraction was meeting and honoring Professor once more, this fact constitutes as remarkable a commentary as anything could on the hold which he maintained on his friends.

These dinners were repeated every year at the same time and place until 1910. In 1911 Professor was on a tour around the world, and no dinner was held. In 1912 Professor's eightieth birthday occurred, on Oct. 21, and in that year the American Society of Mechanical Engineers gave him the large dinner mentioned in his "Reminiscences," already quoted, in the United Engineering Building in New York.

Thereafter the dinners were held at the Onondaga Hotel in Syracuse on Professor's birthday, as his increasing age made it more difficult for him to stand the strain of coming to New York. Up to the very last dinner the list increased of those who, by close association and affection for Professor, felt entitled to be enrolled, and in one case at least the second generation made its appearance at the dinners.

SOME OF PROFESSOR SWEET'S ACHIEVEMENTS

As to Professor's great works, little can be said that the engineering profession does not generally know. At Cornell he had charge of the mechanical end of the first "dynamo" built in America, of which Professor Anthony designed the electric end, and he started there the manufacture of micrometer calipers, which he called "measuring machines," because he preferred the simple English name for everything. He also began there the making of limit gages and standard gages of hardened and ground steel, such as are now common, but which at that day were scarcely known. He not only had these gages made by the students, but he literally fathered their general introduction into shop practice, as well as that of many other mechanical refinements now in common use, but too numerous to mention here. A notable feature of his designing was that he achieved results by leaving things off rather than by putting them on. If somebody had accomplished a given result through the use of a lot of moving parts, he would scheme some simple way whereby the same result could be obtained with the aid of one or two parts.

THE ARTISTIC QUALITY OF HIS DESIGNS

Another feature of Professor's designing, which in a sense was connected with that last described, was his tremendous artistic sense. He had entered engineering through architecture and had realized fifty years ahead of the rest of the American world that true art in architecture consists of a harmonious adaptation of the mean employed to the end desired, not in the addition of superfluous parts for purposes of ornament only. He believed, and rightly, as we now know, that art in machine designing consists in the most direct and harmonious adaptation of the means at hand to the object desired. The fluting of columns, the ornamental paneling of flat surfaces and the like, the use of curves where a straight line would serve and, above all, where a stress was to be transmitted were customary in machine designs only twenty or thirty years ago, but they were all abominations in Professor's truly artistic sight. In matters of appearance, as well as in the mechanism used, he believed in the harmonious assembling of the essential and the absolute elimination of the unnecessary.

This is so much a feature of the best present-day designing that those familiar only with the present do not realize how different were the conditions previous to Professor's precepts and example concerning the beauties of simplicity. He had a saying, "Whatever is right, looks right"; and if something looked wrong, he would analyze it until he found what the wrong was. It is probable that he came nearer to criticizing the work of others in this direction than in any other except in matters involving moral turpitude, such as theft of another man's design or ideas, copying without acknowledgment and the like. In those matters, though he commonly did not say very much, the little he did say was greatly to the point and left the hearer in no doubt at all as to his meaning and his sentiments.

He was quick to acknowledge the merits of the work of others in truly artistic design, as in all other directions. I have heard him speak in terms of the greatest admiration of the splendid simplicity of the lines of the Centennial Corliss engine and of the work of some European designers in which art was served by suppressing ornamentation.

THE STRAIGHT-LINE ENGINE

In the brief autobiography previously quoted Professor mentions some of the details of the Straight-Line engine, but does not tell how remarkable was the work-

manship or how radical was the design as compared with previous practice. At the time I was there, now nearly twenty-five years ago, he was using hardened and ground bushings for the valve gear, so that if a pin became worn, its bush was knocked off and a new one put on, while if the bore became worn, its bushing was knocked out and a new one inserted. In this way the life of these parts was indefinite. The main-bearing shells were solid, but had eccentric cheek pieces of hard babbitt fitted inside them so that rotating up these cheek pieces by liners behind the thick edge took up the wear, but left the center of the bearing surface unchanged. The valve stem was a bush of hard babbitt about two feet long, hand reamed to an exact fit on the ground valve stem. The babbitt bush was held in a gland, so that it could accommodate itself to the line of the valve stem; the piston-rod packing was the same, except much shorter. This construction made an absolutely tight joint, which was good for years without any adjustment whatever and with an irreducible minimum of friction. Special trams were invented, which centered themselves to the actual bore of the cylinder and permitted the main-bearing shell seats in the frame to be bored absolutely at right angles to the center line of the cylinder.

Professor made a study of the action of oil in moving machinery; and when the Stright-Line engine was built, it was an engine with the lubricating system built into it instead of being an engine with some oil cups stuck on it. It is probable that the system of lubrication, which was an inherent part of that engine twenty-five years ago, has not been bettered since. He not only schemed simple ways to make the oil go where he wanted it to go, but equally simple ones that prevented it from traveling where he did not want it to go—for instance, the knife-edge rings mounted on the shaft close to the ends of the main-bearing shells and inside of hoods cast in the frame, which caught the oil thrown off by the knife-edges and returned it to the oil cellar in the base of the main bearing. These things are simple and obvious enough when they are once done, but those whose memory goes back so far will remember what a huge step in advance they constituted over anything that had been done up to that time.

The question of the relationship between mathematics and engineers is one that has often been fought over. In the reminiscences already quoted Professor gives the disastrous results of the first attempt to teach him algebra. I doubt whether any subsequent one was more successful, for he knew nothing of that science or of any higher mathematics. Yet by intuitive reasoning power, sometimes assisted by simple but marvelously ingenious applications of graphics, he achieved results that were positively startling. The best illustration of this is the story of him told by Mr. Armstrong.

On one occasion during a call from some professor the latter spoke of the very difficult problem in geometry which the mathematicians had just succeeded in solving—namely, that if three circles of different diameters are drawn in any position in a plane and a pair of tangents are drawn to each side of each pair of circles and prolonged to their intersection, the intersecting points of all three pairs of tangents will lie in a straight line. Professor thought this over for a few minutes and said: "Yes, certainly, I can see that that is true."

The other professor said: "I guess you don't understand, Professor. This is a very difficult problem, and we have just finally accomplished its solution. I don't think it is as obvious as you think it is."

"Why, yes," said Professor, "of course it is obvious. Instead of three circles in a plane, take three balls, lying on a surface plate. Instead of drawing tangents, imagine a cone wrapped around each pair of balls. On top of the three balls lay another surface plate. It will rest on the three balls and will necessarily be tangent to each of the three cones. The apexes of all the cones must lie in the interesction of the two surface plates, and as the intersection of two planes is always a straight line, the apexes of the cones will lie in a straight line. It seems to me that this is perfectly obvious." So it was to a man who could think in those terms, but to how many of us, no matter what our mathematical training, would it be "obvious"?

This was characteristic of his method of attack on all new problems. He did not have to, and would not, play the game according to the accepted rules in such cases. He would strike out a method suited to the conditions, choosing a simple method of attack from a totally unexpected direction, and yet so logical that it could not for a moment be denied. Of course, problems did arise not capable of solution even in these ingenious ways, and these he would mull over in his mind. If he finally became convinced that he could not solve them, he had no more false shame about asking for assistance than would a boy in asking help of his father for his arithmetic lesson.

HIS EXTREME MODESTY

It is probable that no man ever achieved the standing in a profession that Professor had and yet was so unwilling to admit that he had it, or if he were forced to admit this, that he deserved it. His modesty was literally incurable. He came of plain people. He was neither proud nor ashamed of this origin; he simply recognized it as a fact. But that his achievements entitled him, not only to professional distinction, but that his ability and above all the charm of his personality qualified him to ornament a position in any society was something he could never be made to believe. With this same habit of mind went other characteristics. He had come up through the ranks as a mechanic, and he never felt that he was entitled to very much greater pay than a mechanic. He never permitted the Straight-Line Engine Co. to pay him a salary bigger than would be expected by the foreman of a good-sized shop. He lived in the same simple way, which was very comfortable, without the slightest sign of meanness or niggardliness of any kind and yet without a penny being wasted or spent for ostentation.

As a sort of corollary to his own beliefs and conduct in this respect he felt very strongly that other people perhaps lived better than they should, spent more on their living than they were justified in doing. The point of view that, for most men to command a position or standing of a given kind, they had to live, in a broad way, up to certain standards, never appealed to him in the least. The fact even that a man by living too simply might shut himself off from the possibility of increasing his income out of all proportion to the increase in expenditure that it required never entered his head. He had an instinctive belief that it was wrong and nothing could alter that. He never made himself a bore by preaching his own beliefs, but once in a while he would let drop a sentence that meant volumes.

HIS KEEN SENSE OF HUMOR

Very often a man with high ideals of conduct is spoilt for human companionship by a sense of dignity that replaces or stifles his sense of humor. It was far otherwise with Professor. He had a keen sense of humor and could illustrate his point with a short story or a witty saying in a manner characteristically American, and a good story well told was sure of at least one appreciative hearer when he was present. I have seen him almost convulsed in a quiet, chuckling laugh over something that hit his fancy especially. At the dinner in October, 1915, one man told a number of stories, mostly Southern stories about negroes. These amused Professor so much that he wrote afterward to the story-teller and asked to have some of them written out for his further enjoyment.

Here again, perhaps, his modesty played a big part. He was never in his own mind a king amid inferiors, but one of a group from each of whom he could learn as eagerly as they could learn from him. This trait kept up his spirit of fellowship and made companionship agreeable, and leadership natural, to him.

HIS TIRELESS HELPFULNESS

I have already spoken of Professor's helpfulness, but I cannot refrain from reverting to this subject again, because it was so borne in upon me during my service with him. Nearly everybody in central New York who was doing anything mechanical, and a very large percentage of those in a vastly greater region, knew or knew about Professor. They would come in, exchange greetings, introduce themselves, if necessary, and proceed at once to outline the peculiar problem or difficulty that they had in hand at the time. This all went as a matter of course. The famous sign, "Visitors Always Welcome," engraved in the stone over the doorway, had its inception in Professor's temperament, and these people were as absolutely welcome as though they had been paid clients, though in over twenty years I never knew one of them so far to forget his dignity as to offer to pay for the help that he got. The idea that he should be paid never entered Professor's head, except when it was put there by someone else, and never stayed then. He got his pay in the interest that he took in the things brought to his attention. Sometimes a little fun of a quiet kind was mixed with the interest.

Two cases I remember that happened while I was there; they are only typical of thousands of others. A man came in greatly obsessed with the idea that the steam engine incurred a serious loss by the necessity of starting and stopping its reciprocating parts twice during every revolution. After he had explained his cure for the trouble, Professor said: "Now, you know it does not cost anything to push on a thing, no matter how hard you push, as long as the thing does not go anywhere. Take the case of the steam in a steam boiler. It is pushing on every square inch of the boiler's surface with a hundred pounds' pressure; but as long as the boiler does not give way, it does not cost anything." This was the simple but unshakable foundation upon which he proceeded to build up an explanation that removed the man's obsession without expense or even pain to himself.

A TYPICAL INCIDENT OF HIS HELPFULNESS

On another occasion a man came in, considerably excited over the amount of heat that the steam engine discharged as latent heat in the exhaust steam. On this occasion, as I guess happened pretty frequently, I broke into the conversation, because this trenched on the subject of thermodynamics, with which at that time I was quite fully loaded. This unfortunate individual had found that a pound of exhaust steam contained nearly one thousand thermal units. He had then gone to a professor in one of the universities and asked him how hot a thousand thermal units would heat four pounds of air, and the professor had calculated for him that it would heat the air to over a thousand degrees. We will hope that the questioner had not mentioned to the professor that the thousand degrees was to come from exhaust steam. With this information the man proceeded to line out a system whereby he could heat this quantity of air to that temperature and thereby increase its pressure and make it do a lot of useful work. I explained that a stern and natural law, known as the "second law of thermodynamics," stood in the way of all such feats and that the loss which he lamented was a part of the inevitable, natural losses incident to converting heat into work; moreover, that neither his scheme nor any other could prevent this loss unless the whole fabric of our scientific knowledge collapsed into a ruin. After he had gone, I said to Professor: "Did you want me to take so much of a hand in that discussion?" He said: "Yes, that was right. Get that idea out of that poor man's head and prevent his wasting his own, or somebody else's money."

HIS INSPIRATION IN THE SHOP

It is perhaps as remarkable a commentary as any upon Professor's character that in spite of this remarkable temperament, which generally implies an easy-going disposition and, therefore, poor ability in handling labor, he had a good idea of what a day's labor was and surrounded himself with subordinates who were able

and willing to get it for him, always, of course, without any bulldozing, rough language or any of the other methods of the "hell-driver." To a great extent he got it because he had inspired the men in the shop with some of his own spirit and they were willing, without much driving, to give a fair day's labor for the fair day's pay that they always got. On one occasion, however, his foundrymen struck. Not being imbued with the modern doctrines of political economy, Professor fought this strike by simply paying off his men and refusing to talk to any of their representatives, organizers or others until they were ready to go back to work again, which they eventually did on his terms.

This illustrates what I might better have said earlier, that his marvelous disposition did not obscure his judgment as to what was right for himself and his stockholders and that, if he were forced to fight, he would fight—not with violence, but with great determination —for what he believed to be right. I suppose that he would turn in his grave at my saying this, because the mention of war or personal conflict was utterly abhorrent to him. The point of view that our sons might come to a worse end than to lay down their lives in defense of the rights of their country or humanity—that, in short, there could be an ethical and moral side to war—was a point of view that could not be made to enter his head.

When all is said and done, while I do not believe that the world knows now or will long remember half that Professor did for the furtherance of mechanical engineering in its broader sense, nevertheless it seems to me that in him his character exceeded his achievements. As a moral force in the world he was greater, because rarer, than his achievements.

I can never forget his unfailing modesty, his absolute unselfishness, his helpfulness without thought of the cost to himself and the way he never preached, but unfailingly lived, the golden rule. To these things must be added his *human* personality and his magnetic power of attracting to himself a large percentage of the men he met, of holding their interest and affection for long years, generally for life, and of inspiring them with high ideals of conduct without ever mentioning the subject. Remember, too, his marvelous ability to instruct men technically and to broaden and simplify their methods of thought.

These seem to me to be the outstanding characteristics which, possessed by a man whose achievements equal those of the greatest engineers of our time, put him upon a pedestal so that he overtops them all in those things that truly make for greatness.

SOME TYPES OF SUSTAINED-WAVE GENERATORS USED IN RADIO TELEGRAPHY

By WILLIAM C. BALLARD*

Under the second heading as stated in last month's article we may logically class the Poulsen Arc, Marconi Undamped System, and the Oscillating Bulb Transmitter.

POULSEN ARC

The Poulsen Arc at the present time is by far the most generally used type of sustained-wave generator, and seems to be steadily gaining in popularity. The United States Navy has in the past few years equipped a large number of its Atlantic and Pacific coast stations with this apparatus and is at present erecting additional transmitters of exceptionally high power at San Diego, California; Pearl Harbor, Hawaii; and Cavite, Philippine Islands. These stations are more powerful than any at present erected, the two larger installations at Cavite and Pearl Harbor being designed for 350 KW input, delivering 200 amperes into the antenna circuit.

The forerunner of Poulsen Arc development consisted in some fundamental experiments made several years ago by Duddell, an English physicist and engineer, in which he shunted a direct current arc by an oscillatory circuit consisting of an inductance coil and a condenser. Duddell found under proper conditions that the arc set up sustained oscillations in the shunt circuit whose frequency was approximately the natural frequency of the circuit,

$$\text{i. e., } f = \frac{1}{\sqrt{2\pi LC}}.$$

The action of the arc under these conditions can be readily explained by its peculiar volt ampere characteristic, which indicates that as the current thru the arc is increased between certain limits the voltage drop across the arc decreases, thus acting as a sort of "negative resistance" if we may use the term.

While experiments of the above nature undoubtedly led to the perfecting of the Poulsen Arc, yet the theory involved in Duddell's experiments has little or no connection with the operation of commercial arc transmitters. It has been definitely determined that in the region in which commercial arcs are operated the "negative resistance" characteristic is almost entirely absent.

The Poulsen transmitter in its commercial form consists of a 500 volt DC copper-carbon arc operated in a strong transverse magnetic field, and enclosed in a gas filled chamber. Provision is made for cooling the copper electrode by casting the same hollow and circulating cooling water thru it. Cooling coils supplied with circulating water are also provided inside the arc

*Instructor in Electrical Engineering.

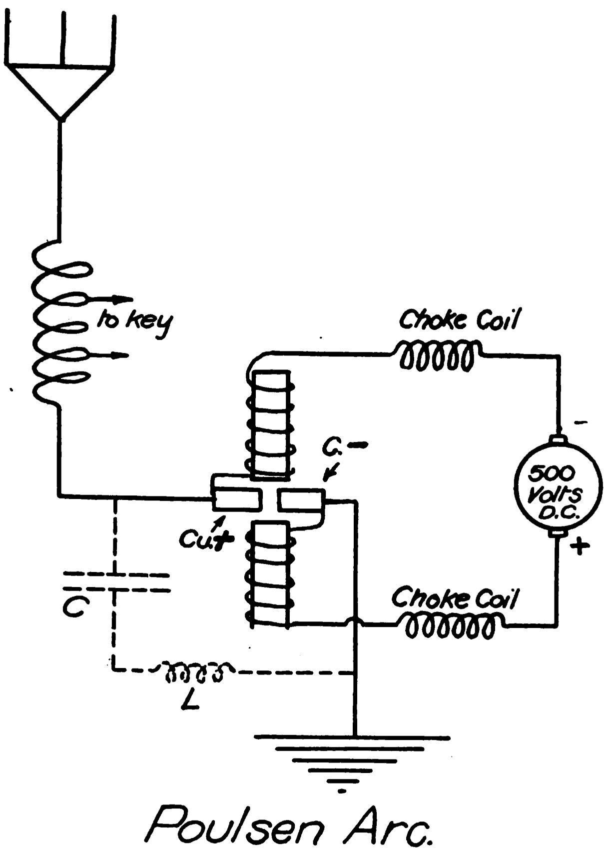


FIG. 1

chamber to conduct away as much heat as possible. The carbon electrode is slowly rotated to equalize the wear on the same.

Connections are shown in Fig. 1. It is usual practice to connect the arc directly between the antenna and ground where the capacity of the antenna will permit. The equivalent circuit is shown in dotted lines, the condenser "C" being equivalent to the electrostatic capacity of the antenna and coil "L" representing its inductance. The choke coils inserted in the supply leads have a double function; they tend to maintain the D. C. supply at a constant value and also prevent the high frequency current from getting into the generator where it would cause serious damage.

The action of the arc may be briefly described as follows. Let us assume that while the arc is burning steadily the condenser-inductance circuit is suddenly closed.

The condenser now begins to charge and since the generator current is maintained practically constant by the action of the choke coils, this charging current will be diverted from the arc, and may attain such a value as to reduce the arc current to zero and extinguish the arc. In a very short period of time, the condenser will be charged to the full potential across the arc, and then due to the electrical inertia of the inductance the current will continue to flow even after the condenser has been fully charged and thus slightly overcharge the condenser. However, it is a well known fact that voltage required to jump the space between two electrodes is very much greater than that required to maintain the arc after once having been started. This is due to the ionization of the space between the electrodes by the passage of the initial spark, after which the air no longer exhibits dielectric properties but becomes a fairly good conductor. Thus when the condenser has been charged to a sufficiently high voltage the arc will break down and the condenser discharge thru the arc since the passage of the first spark will very rapidly ionize the air and reduce the arc voltage to a value much smaller than the potential to which the condenser has been charged. Then the condenser will discharge thru the arc until the voltage of the arc and condenser are equal, and then due to this inductive inertia of the coil, will continue discharging beyond this point until the condenser voltage is actually lower than the arc voltage. This difference of voltage will start the condenser charging again extinguishing the arc and repeating the cycle as described above. It is naturally desirable to have the condenser charge to as high a voltage as possible, the energy absorbed by the condenser being proportional to the square of the maximum voltage. This means that the arc should not break down before this maximum value of potential is attained. Under ordinary conditions, as soon as we extinguish an arc, the air immediately becomes de-ionized and regains it original dielectric strength, but on account of the rapidity with which this cycle is repeated the ionization effects of the previous discharge are not completely neutralized before the next discharge takes place, with the net result that the arc ignites and the condenser discharges at a voltage much lower than it otherwise would. Hence special means must be provided for the de-ionization of the arc between discharges. This is accomplished by surrounding the arc with some hydro carbon gas, the use of the transverse magnetic field, and the cooling of the copper electrode. Maintaining the copper electrode as cool as possible reduces the ionization since a cold electrode will cause ionization to a very much smaller degree than if the same electrode were incandescent or even warm. The hydrocarbon atmosphere, originally furnished by introducing illuminating gas directly into the arc chamber is now produced by feeding alcohol directly into the arc chamber where it vaporizes, and seems to cool the arc in addition to its rapid de-ionization action. The effect of the magnetic field seems to be a combination of quenching action with which we are familiar in its application to "magnetic blowouts," with the additional cooling effect produced by blowing the arc out into a loop away from the edges of the electrodes so that it may be more readily cooled by the surrounding gas. The problem of cooling the arc transmitter is certainly not the least of the difficulties involved, since arc transmitters in which the input to the arc is in the nieghborhood of 100 KW are in daily operation and transmitters of 350 KW input are being planned. Signalling with this type of transmitter is accomplished by short circuiting a few turns in the antenna circuit as shown. Thus when the key is depressed the wave sent out will be shorter than the wave sent out when the key is raised, and by tuning to the shorter wave the receiving station is able to read the

message, although the antenna current at the transmitting station is of a continuous constant value, varying only in frequency.

Fig. 2 illustrates a commercial arc transmitter used at Tuckerton, N. J. This arc is of 60 K W capacity, delivering 120 amperes to the antenna. The accompanying illustration shows the construction of the duplicate transmitting contactors operated thru relays by a small Morse key. The series of switches are arranged to throw in either set of contractors.

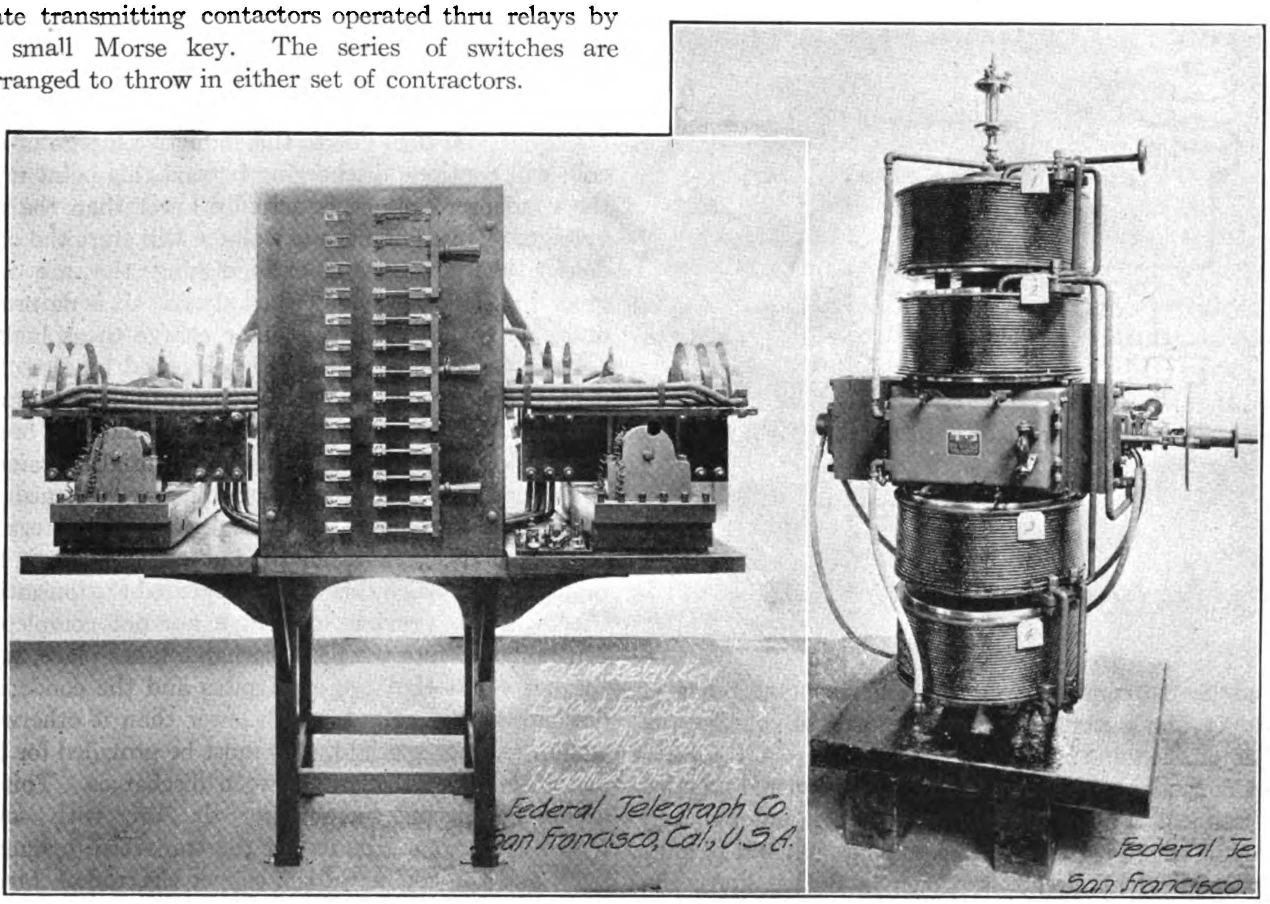


FIG. 2

As the result of an exhaustive test made at the Arlington Station near Washington, D. C., between a 100 KW spark transmitter and a Poulsen transmitter of the same power, the great superiority of the sustained-wave transmitter was very clearly demonstrated, especially in times of severe atmospheric disturbances, when signals from the arc could be easily copied while signals from the spark were entirely lost. Of course it must be understood that any other type of sustained-wave transmitter of equal output would have produced the same results, the superiority being inherent in the continuous wave transmission and not in the particular type of continuous wave transmitter.

MARCONI SYSTEM

Several years ago the Marconi Company developed a system for producing what closely approaches sustained oscillations by an ingenious application of several spark transmitter circuits. The general scheme is indicated in Fig. 3. Several separate spark transmitter circuits are inductively coupled to the antenna circuit. In each of the transmitter circuit a rotary spark discharger is located. All these dischargers are mounted on the same shaft, but are so arranged that the circuits discharge in rapid succession instead of simultaneously. Consider circuit "a" as having just discharged. Its effect will be the production of a damped wave train in the closed oscillating circuit, and also in the aerial circuit to which it is inductively coupled. Normally these oscillations would very soon die out, but before this has happened circuit "b" discharges and the current in the antenna is the sum of the currents produced by circuits "a" and "b", likewise circuit "c" discharges when the effect of circuit "b" is decreasing, thus producing an effect similar to other sustained-wave transmitters. The adjustment of this type of transmitter must be exact, else the effect of the discharge in circuit "b" may be to neutralize the wave from circuit "a" instead of increasing and maintaining it. It is reported that the Marconi Company are attempting to use this system for transatlantic communication at the present time.

OSCILLATING BULB

One of the most ingenious as well as recent schemes for producing continuous oscillations is that employing the vacuum bulb. This piece of apparatus was primarily developed as a detector and amplifier for radio receiving and its oscillating properties are of comparatively recent discovery.

The apparatus consists of an evacuated bulb containing a heated filament and two cold electrodes. One of the cold electrodes consists of a metallic plate located

a short distance away from the filament. Midway between the filament and plate the other electrode commonly known as the grid, is placed. Briefly the

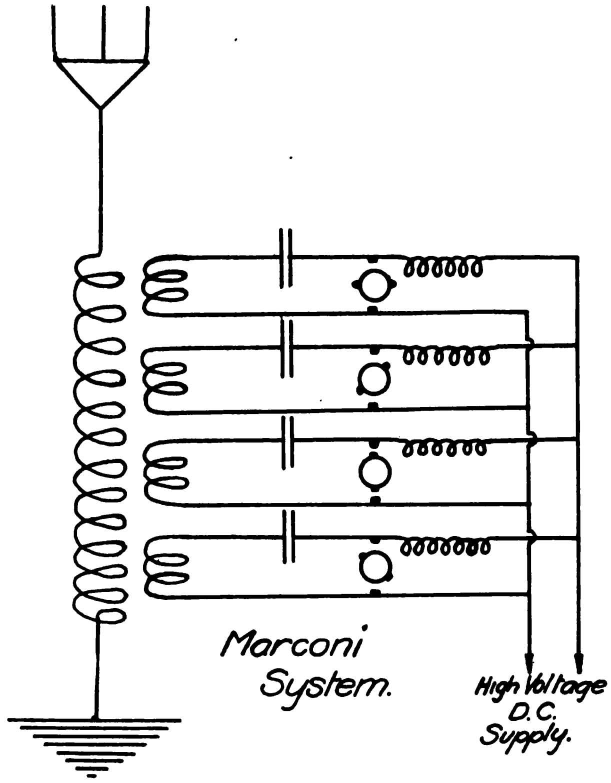


FIG. 3

action may be explained as follows: When the filament is brought up to incandescence by an outside source of current, it emits a stream of negatively charged ions, which are radiated in all directions, some of them naturally passing thru the rigid electrode and impinging on the plate. Thus if the circuit is completed externally between plate and grid we shall be able to detect a very slight current flowing from plate to filament to which this ionic discharge is equivalent.

Incidently this wing current may be increased by the insertion of an electro motive force of proper polarity and value in the external circuit. Now if we electrostatically charge the grid to given potential in the proper direction with respect to the filament the negative ions will be electrostatically attracted and the number impinging on the plate, and hence the plate current, will be increased and when this potential is reversed, the plate current will be correspondingly decreased. Thus any potential variation of the grid will be reflected as a current variation in the plate circuit. In properly designed apparatus of this character it is thus possible by applying small varying potentials to the grid to obtain faithful reproductions in the wing circuit without lag or deformation and of many times the original intensity. The telephone engineer will immediately recognize in this type of apparatus the long sought for telephone relay in theoretically its ideal form; and it is to its wonderful amplifying properties that transcontinental wire telephony owes its present high state of perfection.

Referring to the diagram in Fig. 4, let us suppose some small electrical disturbance has caused momentary oscillations in the inductance-capacity circuit shunted between grid and filament. Under ordinary conditions the circuit would oscillate for a few cycles and then the current would die down to zero, due to the resistance of this circuit. If the current decay is produced by a constant value of resistance, then the energy of each oscillation will bear a constant relation to the preceding one. Suppose this relation is seven-tenths, then we will lose thirty per cent. of the energy between each oscillation. But this oscillating voltage which is impressed between filament and grid produces a current variation in the wing circuit of many times the energy required to charge the grid. If we electromagnetically couple these two circuits together by means of the coupling coils L_2 and L_3, we can transfer back to the grid circuit enough electrical energy to counteract the thirty per cent. loss due to the resistance of the circuit. Thus this initial oscillation, instead of dying out, will be reinforced by the action of the wing circuit, which is supplying all the losses, and will therefore continue indefinitely.

Now by magnetically coupling the aerial circuit to the wing-filament circuit it will be possible to transfer a large proportion of the energy of this circuit to the antenna and thus produce a sustained high frequency current of absolutely constant amplitude. Up to the present this type of apparatus has not found a very large application in radio telegraphic communication, due to its inherent low power, but as a radio-telephone generator, it seems to be almost unapproached. If we listen to the signal sent from this type of apparatus with an ordinary rectifying crystal receiving apparatus, we will hear a faint click when the transmitter circuit is made and again when it is broken.

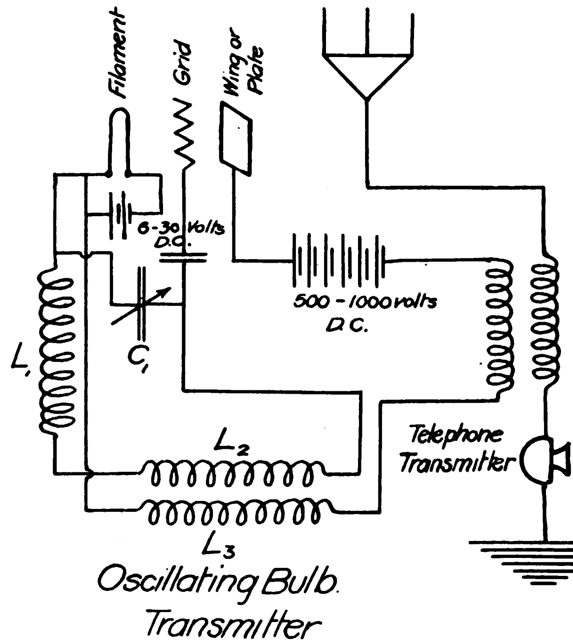


FIG. 4

Between these instants no sound will be heard in the telephone due to the fact that the crystal in rectifying the incoming wave transmits a continuous direct cur-

rent to the telephones which naturally produces no sound. But if we have some means of controlling the successive amplitudes of the antenna oscillations so that their successive maxima will correspond with the sound wave which it is desired to transmit, then the rectifier current in the receiver telephones will reproduce, as sound, these amplitude variations. In small radio telephone installations such as shown in Fig. 5 the transmitter is connected directly in the antenna circuit and directly modulates the antenna current to correspond with the resistance changes produced by the impinging voice waves.

By a modification of this system the transcontinental and transatlantic telephone communication radiated from the government station at Arlington (Washington, D. C.) was made possible and although the radiated power in these tests was only about 11 KW yet there is no reason why this apparatus could not have been enlarged indefinitely and conversation transmitted any desired distance. Unfortunately apparatus of the character installed at Arlington is very expensive both in first cost and maintenance; but the limit of transmission is only determined by the appropriation available, if there were a sufficient demand for the same, it would be perfectly possible to maintain regular telephonic communication across the Atlantic.

Fig. 6 illustrates a single bulb Oscillion transmitter as supplied by the DeForest Radio Telephone and Telegraph Co., designed for ship service and which is capable of transmitting either the conventional Morse signals or actual conversation.

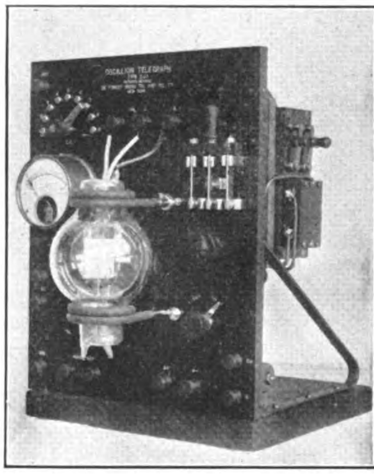


FIG. 6

FIG. 5

EDITORIAL

(Continued from page 87)

often finds in the engineer's work mistakes which could have been avoided had the latter been more familiar with even the most fundamental laws.

The student preparing himself for the engineering profession, in his ardent desire and undue haste to start on engineering problems, cannot see why he should spend practically his first two years at college studying the fundamental sciences, and looks upon this preparatory work as a useless drudgery forced upon him by the faculty. He fails to see that engineering is nothing but applied science and that unless he does study these sciences he will not have a foundation on which to build. It is well recognized that the day of the guess work engineer is past, and that, if anything, our engineering courses should be still more fundamental than they are now. If a man has had a thorough foundation he can apply himself to any problem and work out the details. What the commercial world demands is not so much the man who knows all about a particular type of engine but the man who can solve problems starting from their basic aspects.

The Annual Dinner of the Cornell Society of Civil Engineers will be held Friday evening, January 19, 1917, at 6:30 p. m., at the Hotel Breslin, New York City. Tickets, $3.00. Speeches are to be curtailed. Sibley men are cordially invited.

The dinner is had on the date fixed to accommodate engineers from out of town who attend the annual meetings of the several engineering societies.

A PLEA FOR ACOUSTIC ENGINEERING

By ERNEST MERRITT*

It is generally recognized nowadays that all branches of engineering rest ultimately upon the same foundations, the most important features of which are first, a knowledge of the physical sciences as broad and deep as possible; second, familiarity with the methods of applying this knowledge to engineering problems; and finally, certain qualities of mind and character, which, while very hard to define, are most essential of all.

But although all engineers build upon the same foundation, it will be noticed that the successful engineer usually gives evidence of individuality by adding a more or less attractive and conspicuous tower to his edifice. In other words he becomes a specialist in some particular branch of engineering work, so that when an important problem in this line comes up he, or some one like him, is the one to be chosen for its solution. Many of the most important branches of engineering were developed first as the specialties of a few engineers who possessed in unusual degree the power of anticipating the future demands on their profession. I wish to point out here the need of specialists in a new branch of engineering, namely acoustic engineering.

I would include under the term acoustic engineering all of the practical or engineering problems in which sound is concerned. For example, the design of a large and efficient automobile horn, or of a noiseless typewriter; the design of an auditorium that will have good acoustic properties, or of a dining hall where the guests will not be disturbed by the rattle of dishes and the conversation at neighboring tables.

At first thought there would seem to be "nothing in it" for an engineer in problems of this kind. The engineer must earn his living by his profession, and it would seem as tho problems of this sort either would have no commercial aspects at all or would be of very small importance from this point of view. I think, however, that a little consideration will show that this is by no means true. I am convinced that the time is coming when the demand for specialists who can handle such problems will make the field of acoustic engineering a profitable one; in the case of certain kinds of acoustic problems this time has already come. Let us consider a few illustrations in support of this view:

Take for example the problem of designing a big auditorium. This is a problem that obviously falls into the field of acoustic engineering and in its most important aspects has already been solved. The work of the engineer in such cases would consist in applying methods and knowledge already available. But although the method of preventing or of curing the common defects of auditoriums was developed by Professor Sabine at Harvard twenty years ago, it does not seem to be at all generally known. The acoustic engineer has an excellent opportunity here for a campaign of education.

If it pays to build an opera house and to pay singers at the rate of a thousand dollars or so a night to sing in it, would it not also pay to have the building so designed as to enable the music to be heard to the best advantage? If a hall is to be built for public speaking would it not pay to consider not merely the artistic appearance of the hall and its convenience as regards entrances and exits, but also its fitness as a place in which a speaker can speak without straining his voice and a listener can hear without straining his ears? In such cases specialists are available to take care of the problems of heating and ventilation. If the architect is up to date he will consult an illuminating engineer regarding the lighting. Why should he not consult an acoustic engineer regarding the acoustics of the hall? As a matter of fact in important cases he *does* consult an expert. But unfortunately he usually does so after the building is completed. And while it is often possible to patch things up so as to make a badly designed auditorium usable, the expense involved is likely to be very considerable and the final result is rarely entirely satisfactory. A very striking example of this fact was furnished by a theater built in New York not many years ago, in which the acoustic defects—echoes and reverberation—were so serious that extensive structural changes were required. Relatively simple calculations, involving at the most not more than a day's work, would have shown in advance that the design was faulty and would have indicated the general character of the changes that would have to be made in order to remedy it. In engineering as in medicine it is better to prevent a disease than to cure it—and usually a great deal easier.

The Cornell Campus furnishes several examples of the type of problem that has just been mentioned. The auditorium in Sibley Dome is one. In this case the very serious reverberation that was a source of great annoyance when the hall was first completed has been in large part removed by the application of Sabine's methods. The reason that the cure was not complete is not that the methods are inadequate but that the money available was insufficient for a complete cure. Bailey Hall constitutes another problem for the acoustic engineer. When well filled it is satisfactory. When half full it is less so, and although the listener may not notice any difficulty in understanding a speaker yet he will be likely to experience a vague feeling of discomfort before the address is over. But if the audience consists of only a few hundred it is difficult to understand the speaker even when sitting only a few rows distant. It would be possible, even now, to make the hall satisfactory from the standpoint of acoustics for any audience; but the expense could be almost prohibitive. If the new Drill Hall is ever to be used for music or for addresses a new and extremely difficult problem will probably be met.

*Professor of Physics, Cornell University, Ithaca, N. Y.

Another type of problem is furnished by the talking machine. The reproduction of sound by the phonograph is certainly extraordinary, and we get out of the instrument, even in its present form, a great deal of pleasure. Yet the reproduction is far from accurate. In fact it is extremely bad even in the best instruments. The sound as reproduced is distorted in all sorts of ways. Certain tones and overtones are louder than they should be: others almost fail of reproduction. In the sounds of the voice the overtones do not appear in their proper relative intensity, so that the tone quality is modified. The ear instinctively makes allowances and we recognize many things in the phonograph simply because we know they ought to be there. But there is room for great improvement, and the engineer who brings about the improvement,—or at least the company which makes use of his designs—will certainly find it profitable. The acoustic problems in telephone work are similar to those that arise in connection with the talking machine.

The war has given added importance to several problems that fall into the field of acoustic engineering. For example, instruments utilizing the microphone, or some other sound amplifying device, are used to detect the approach of air ships. Doubtless acoustic engineers somewhere, although probably not working under this name and not especially trained for the work, are attempting to make noiseless engines for air craft so as to make detection by acoustic methods impossible. Signalling between ships by means of sound transmitted through the water had acquired considerable importance even before the war as a substitute for the fog horn, which is often extremely unreliable. The fact that acoustic devices are able to detect the presence of a vessel even at a considerable distance by the sound of its propeller has been an important factor in submarine warfare. All of these applications of acoustic methods will have their applications also in times of peace and will help to furnish occupation for the acoustic engineer.

There is one type of problem in acoustic engineering—in some respects the biggest and most important of all,—which, so far as I know, has never yet been attacked in any systematic way. This is the problem of preventing undesirable noises. If a typewriter could be invented which, while in other respects satisfactory, also possessed the quality of noiselessness, can any one doubt that it would drive every other machine out of the market? Does a purchaser prefer an automobile with a noisy engine or one that is as nearly as may be noiseless? Even a device for preventing squeaky shoes would have money value. In connection with railroad travel all sorts of expensive devices are employed in order to add to the traveler's comfort. Why not add to his comfort still more by reducing the noise of the train? In all aspects of city life comfort can be increased by reducing noise. The problems are innumerable. And, what is almost equally significant from the engineer's standpoint, the public is gradually coming to see that such problems are worth considering. One of the comic papers recently published a picture showing some absurd device by which a guest in a restaurant could shut off the sound of the orchestra from his particular table if he desired. The picture was entitled, "How to take the Din out of Dinner, and put the Rest in Restaurant." Evidently the need of the acoustic engineer is getting to be generally recognized!

SOME RELATIONS BETWEEN RAW CLAY AND PROPERTIES OF CLAY PRODUCTS

H. RIES*

The wide-spread and increasing use of structural clay products in recent years, has not only lead to a vigorous growth in the industry which supplies these materials, but has also called for a careful study of the methods of manufacture employed and the raw materials to be used, not only with a view to cheapening the methods of production, but also improving the character of the product, and widen its range of usefulness.

These developments have not been confined solely to the higher grades of burned-clay wares, but have also affected the commoner products such as building and paving brick, and it is to these that the present article relates.

It is, of course, well recognized, that any finished product produced from raw materials cannot be satisfactory unless the former are of the proper character, and this applies to no mineral substance, more than it does to clay. Indeed not a few of the faults seen in bricks may be traceable to this source, a point now well recognized by many, but formerly too often overlooked.

All clays have to be molded by machinery, one prominent and much used type, the stiff-mud machine, requiring the clay to flow through a die in the form of a rectangular bar.

So sensitive are clays to variation in the method of treatment, that even slight changes in the construction of the die, may cause marked variation in the structure of the brick. Laminations (Fig. 1), formerly much complained of in paving brick may be caused by excessive plasticity in the clay, or faulty construction of the stiff-mud machine. Tearing of the clay can be brought about by improper die lubrication, insufficient

*Professor in Geology, Cornell University

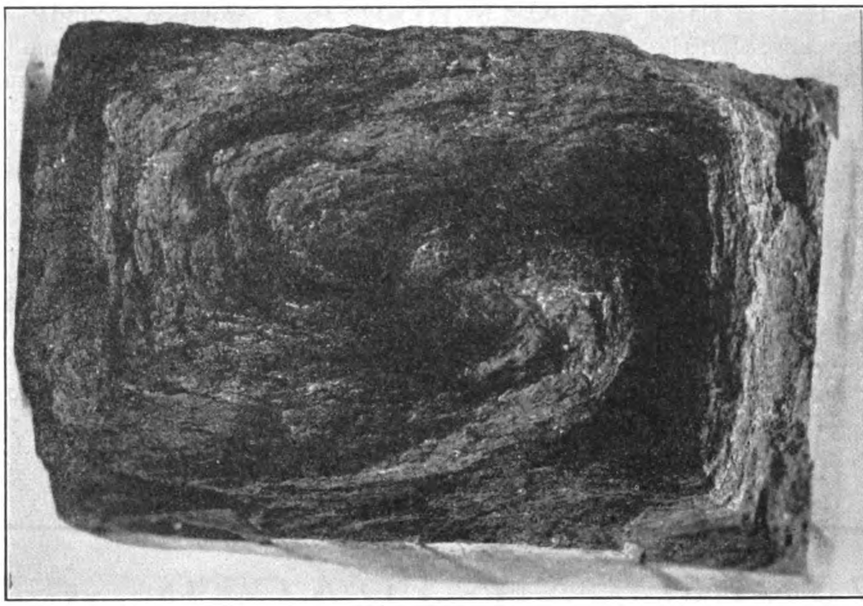


FIG. 1

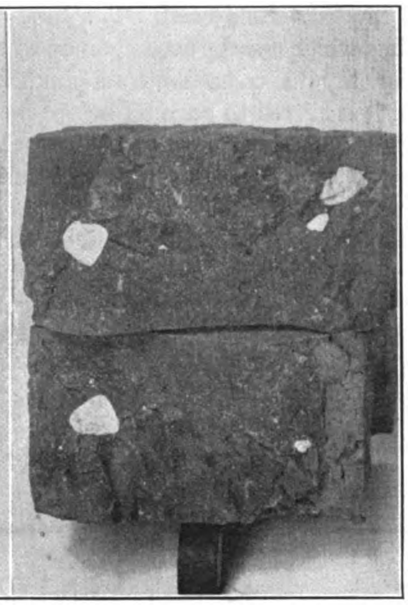


FIG. 2

mixing, or deficient plasticity. Indeed, in making stiff-mud bricks each clay is a problem by itself, and must be intelligently studied.

Lack of thorough preparation may be responsible for lumps of undisintegrated clay and pebbles in the brick, which if they do not cause cracking in the drying and burning, are likely to develop weakness in the burned product, their effect on the transverse strength being most noticeable. Limestone pebbles may be an additional cause of trouble, because on burning they change to quick lime. This will absorb moisture from the atmosphere, swell, and burst the brick (Fig. 2), if the latter is not very hard burned, or if the lime lump is not very small.

The character of the raw material moreover will determine to a large degree the density and hardness of the finished product. Clays show a wide range of behavior in the kiln. Some, especially the sandy ones, will not burn to a vitrified, or even moderately dense product, and the practice followed by some brick-makers of adding sand to the clay, may seriously interfere with the attainment of this desired end. A small amount of sand mixed with a very plastic clay often does no harm, and may be desirable since it reduces the shrinkage, but many small plants add it in such quantity, to facilitate the working, as to produce a porous brick, not acceptable to the engineers.

All clays shrink in burning, until they reach their point of maximum density, after which they begin to swell and become viscous and porous.

This condition of maximum density and shrinkage, is usually called *vitrification*, but the term is really misnomer.

The verb *vitrify* means to make glassy, and if any piece of ware really looks glassy, it has been burned too far, and is worthless. To the clayworker the word vitrification signifies a process of silicate fusion, which in the so-called vitrified wares is not complete.

Clay wares on heating in the kiln gradually begin to soften, due to fusion taking place within the mass, and this change is accompanied by fire shrinkage. The finer-grained portions of the clay fuse first, and as this extends other particles may be taken into the melting portion. As the burning proceeds therefore, the clay becomes denser structurally, and the original pores close up, so that when the condition of greatest structural density is reached, the original, intercommunicating pore spaces are nearly all closed, but new, non-communicating pores or gas blebs are beginning to develop. Burning beyond this point, is accompanied by an increase of these gas-cavities, and lower density, and finally there comes quiet fusion or complete vitrification.

Now the point that the paving-brick manufacturer aims to reach, is that of maximum structural density, as it represents the condition of greatest physical strength.

We cannot judge this accurately by color (except when comparing bricks made from the same clay), by appearance, or by hardness. Probably the only practicable way to determine it is by absorption.

Here, of course, another thing must be guarded against, and that is to attempt setting any definite limit of absorption that shall apply to all so-called vitrified wares, for those used by the engineer and architect may range from some which are so dense, as to show no spreading of red ink applied to them, to others having 5 or 6 per cent. absorption.

The suggestion has been made that when the word vitrified is used in a contract, it shall mean a structural density that does not permit the ware to absorb over three per cent. of its weight after 48 hours immersion, but such a specification is too broad, for it would rule out some good paving brick, and be above the allowable maximum for white floor tile.

We can see therefore, that the use of the word vitrified without any qualification might lead to serious trouble, and that for each class of vitrified ware used, the particular limits of absorption should be properly set.

There are two other defects seen in brick, especially building brick, that can be traced wholly or in part to

the raw materials used. The first of these is black coring, which may be accompanied by swelling. This is commonly due to carbon compounds in the clay, which if not permitted to burn off before the shrinkage of the vitrification process begins, gives the trouble above referred to. Most manufacturers understand how to prevent the trouble, but there are still some who do not.

The second is the white scum of soluble salts which so often appears on building brick, and is often times regarded as an unavoidable trouble. A detailed explanation of this, would consume more space than can be spared here, and we must content ourselves with the statement that it may come: 1. From the clay, and be avoided by the addition of barium compounds; 2. From the kiln gases, and traceable to the fuel, and 3. From reactions between compounds in the mortar and soluble compounds in the brick.

We can see then that many of the faults found in bricks are directly or indirectly due to the nature of the raw material, and can be often remedied by proper treatment of the clay before or during the process of manufacture.

In many districts the manufacturer has overcome these troubles but there are still not a few who seem to be ignorant of the proper method of handling them.

ENGINEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Gray, Prof. McDermott, Prof. Diederichs, Prof. Albert, Prof. Wells, Prof. Ellenwood, Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Lee, Asst. Prof. Pertsch, H. W. Brown, F. G. Tappan, F. L. Fairbanks, J. F. Wait.

The Sibley Journal will furnish, at cost price, its subscribers with the magazines containing the articles abstracted.

A Talk to Young Engineers, by E. W. Rice, jr., president, General Electric Co. **G. E. Review,** Dec., '16.

In an address before the Schenectady Section of A. I. E. E. on Oct. 6th, Mr. Rice spoke of the character of the problems which the engineers of the next few years will have to solve. The technical problems will be similar to those of the past but others of possibly greater importance will be those of economics and politics. Hitherto the engineer has let politics severely alone.

It is the engineer's business to produce wealth: by making discoveries, by making better use of material and labor, by saving by-products, etc. If he is successful there is a constant increase in the wealth of the country.

However there is a constantly increasing class of men acting apparently upon the theory that efficient production is undesirable, that production should be limited to the minimum rather than increased to a maximum, and that the cost of production may be constantly and indefinitely increased without damage to industry or to their own interests. They falsely think that there is only a limited amount of work to be done in the world and that the less work each man does individually the more work there will be left for the other fellow. They seem to think that the fewer the goods produced the more there will be to divide. Whereas the truth is that the more there is produced the more there will be to divide. This is perhaps the most serious problem facing our country and in fact every civilized country. It is impossible to continue to make progress unless we all work together to combat this tendency.

Until comparatively recent times the activities of our legislatures were confined to the rather well known and generally accepted sphere of government. During the last decade or two, however, there has been a demand for legislation of an entirely novel character. Statutes of all kinds for the regulation and restriction of business activities, laws of a paternalistic and socialistic nature, have been ground out at a constantly accelerating rate.

If our Government is to continue to regulate business, and, particularly, if it is to extend the field of its activities into business and institute competition with private individuals, it is essential that the men we elect to our legislatures and to Government offices should be possessed of accurate knowledge of modern business, of which engineering constitutes a most important feature. Modern business is no longer simple; it is highly complex, and, to be successful, demands the highest technical experience, scientific skill, unflagging industry, intellectual honesty, great administrative ability, initiative and resourcefulness to meet the ever changing conditions. Our political bodies as at present constituted cannot possibly administer such a delicate and intricate situation with success. Disaster can only be averted by improvement in the quality and character of our legislatures and executive instruments. Technical men must take a hand in politics or politics will take them in hand and they will soon have no business.

If production is restricted, if success is penalized, if weak and incompetent men are placed in position to control the competent and efficient, industrial disaster will follow as surely as the night follows the day.

The Condensation Pump. An improved form of High Vacuum Pump. By Irving Langmuir, Research Laboratory, Gen. El. Co. **G. E. Rev.,** Dec., '16.

Two new types of condensation pump are described, one built wholly of glass and the other wholly of metal.

In these pumps a blast of mercury vapor carries the gas into a condenser. This action is similar to that in a steam ejector and in a Gaede diffusion pump. The method by which the gas is brought into the mercury vapor blast in the condensation pump is based on a new principle which is essentially different from that employed in the steam ejector or Gaede diffusion pump. In the new pumps the gas to be exhausted is caught by the blast of vapor and is forced by gas friction to travel along a cooled surface. By maintaining this surface at such a low temperature that the condensed mercury does not re-evaporate at an appreciable rate, it is possible to keep the mercury vapor from escaping into the vessel being exhausted. The action of this pump therefore depends primarily upon the fact that *all* the atoms of mercury striking a mercury covered surface are condensed (no matter what the temperature), instead of even a fraction of them being reflected from the surface. It is for this reason that the term condensation pump is proposed.

The condensation pump is characterized by extreme speed (3000-4000 cc. per second, or even more, if desired), by simplicity and reliability, and by the absence of lower limit (other than zero) to which the pressure may be reduced. By the aid of this pump pressures lower than 10^{-5} bars have been produced and measured.

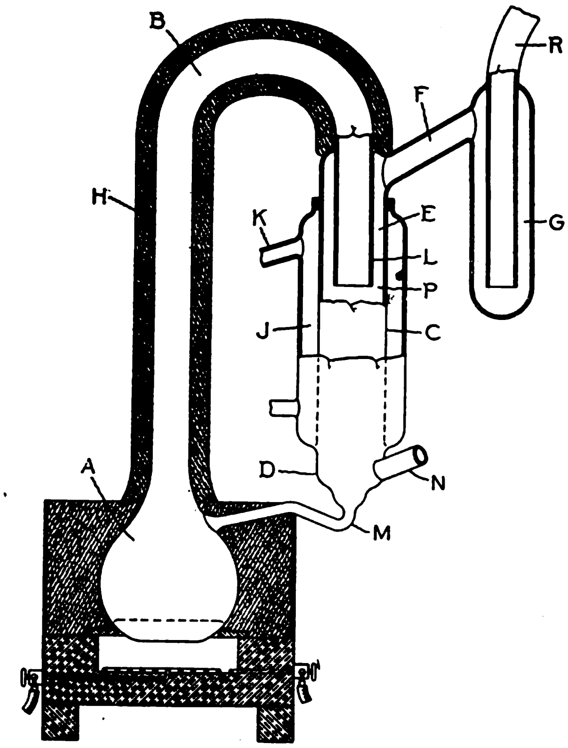
The bar is the c. g. s. unit of pressure and is equal to one dyne per sq. cm. or approximately one-millionth of an atmosphere.

Langmuir considers that the collisions between gas molecules and a solid or liquid body against which they may strike, are in general almost wholly inelastic. Each molecule which strikes a surface thus condenses on the surface instead of rebounding, although it may subsequently re-evaporate. This condensation takes place just as well at high temperatures as at low, but at high temperatures the re-evaporation may occur so soon that it is difficult to detect the condensation. In this case the condensed molecules constitute an adsorbed film. The condensed particles, before they re-evaporate, are held to the surface by the same kind of forces as those which hold solid bodies together. This leads to a theory of adsorption which is in excellent agreement with experimental facts.

It was by a direct application of these ideas that Langmuir was led to construct a high speed mercury vapor pump.

A sketch of the pump made entirely of glass is shown here.

In this pump, mercury vapor from the flask **A** is carried through the thermally insulated tube **B** to the nozzle **L**. The vessel to be exhausted is connected to **R.** The gas from this vessel passes through the trap **G** and the tube **F** into the annular space **E**. At **P** this gas comes into contact with the mercury vapor blast issuing from the nozzle **L** and is thus forced **outward** and **downward** against the walls of the tube **C** and is finally driven down into the space **D** from which it escapes into



the rough pump connection **N**. The mercury which condenses on the sides of the water-cooled tube **C** passes back through the tube **M** into the boiler **A**.

Vacuum pumps are characterized principally by three factors.

1. **Back pressure** against which the pump may be operated. This is the pressure on the exhaust side of the pump.

2. **Speed of the Pump.** This is measured in cu. cm. per second.

In the case of a piston pump this is approximately equivalent to the piston displacement per second.

3. **Degree of Vacuum Attainable.** This is the lower limit to the pressure which may be obtained in a closed vessel connected to the pump.

Most mechanical pumps of the piston type are built to exhaust at atmospheric pressure. But mechanical rotary pumps are often designed to be used in series with "rough pumps" in which case they operate with an exhaust pressure of a few hundredths of an atmosphere (20,000 bars). Molecular and diffusion pumps require exhaust pressures 10 to 100 bars. Such are always used in series with good mechanical pumps. The type of mercury vapor pump here described operates with exhaust pressures ranging from 50 to 800 bars depending upon the amount of heat supplied to boiler A.

With most types of vacuum pump the degree of vacuum attainable depends to a large extent on the exhaust pressure used. This is usually due to leakage back through the pump. In operating vacuum pumps of high speed it is essential to use tubing of large diameter between the pump and the vessel to be

exhausted if full advantage is to be taken of the speed of the pump. This is due to the relatively enormous resistance which tubes offer to the passage of gases at very low pressures.

The exhaustion of a tube continues until the pressure finally becomes lowered to a point at which the leakage of gas into the apparatus prevents a further decrease of pressure. A stationary condition is then reached.

The gas leaking into the vessel does not, in general, pass through the walls of the vessel, but is given off from the walls of the vessel or from bodies within it.

Of course the condensation pump like any mercury pump does not remove mercury vapor from the system to be exhausted. The vapor pressure of mercury vapor at room temperature is in the neighborhood of 2 bars. By inserting a trap such as that indicated at **G** between the pump and the exhausted vessel, this vapor pressure may be lowered to 4.3×10^{-6} bar with solid CO_2 so that the mercury vapor is practically eliminated.

Theories of Magnetism, by Dr. Saul Dushman, Research Laboratory, Gen. El. Co. **G. E. Rev.,** Dec., 1916.

This is the fifth and concluding article of the series on theories of magnetism that have appeared the past summer and fall in the **G. E. Review.** It is impossible to abstract these articles as they consist mainly of a digest of all the important contributions to the subject of magnetism. These articles are of great value in that they bring together all of the important facts and the most recent and important theories invented to explain these facts. The collection of curves, tables, data and results and convenience of comparison of various theories make this series of very great value to anyone desiring to obtain a bird's eye view of the subject and its unsolved problems. The series is also of value as a bibliography of the whole subject.

The Essex Power Station of the Public Service Elec. Co. of New Jersey described and illustrated in **Power,** Nov. 28, 1916. A 50,000 kv. a. power station built on the unit system, with provisions made for an ultimate capacity of 200,000 kv. a. A partial list of the apparatus includes; eight 1373 h.p. cross drum marine-type B. & W. boilers, 16-retort underfeed Sanford Riley stokers (largest ever constructed), 8-Sturtevant Economizers, 2-25, 000 kv. a. G. E. turbines, 12-stage, tandem compound with 8 stages for high pres., 4 for low; Westinghouse condensing equipment; main generator units of 25,000 kv. a. (continuous rating) 60-cycle three phase 13,200-volt running at 1800 r. p. m. Views of many parts of the installation, piping and wiring diagrams also sectional view thru plant are included in the article.

Pressure Tests of Welded Boiler-Tube Vessel by Robert Cramer in **Power,** Dec. 5, 1916. Tests made at the Winslow Safety High-Pressure Boiler Co. and at the Vilter Mfg. Shops with acetylene welded tube specimens. No weaknesses revealed with steam of 800 lbs. pressure and 150° superheat. Some of specimens stood 9000 lbs. per sq. in. water pressure before they ruptured. Types of joints used and views of ruptures are included in the article.

Power Plant Efficiency. By Victor J. Azbe, in the **A. S. M. E. Journal** for December, 1916.

This article deals not so much with the efficiency available in an up-to-date power plant, but rather with the improvements possible in small plants. The preventible heat losses in such plants aggregate about thirty per cent. of the heat supplied in the fuel, and the saving of this heat would lead to enormous financial economies in the generation of power. The author estimates that this would exceed half a billion dollars per year, now lost due to the *inefficiency of man*.

One cause of this loss is that the prospective owner of a power plant often fails to consult a competent designing engineer. The owner cannot be expected to know where and how a greater investment will pay, and should therefore retain a consulting engineer who will not only design the plant, but who will, through a staff of experts, supervise the operation of the plant by means of occasional inspections and suitable instruction of the operating force.

The use of instruments in the boiler room is highly important. Steam flow meters, draft gages, and CO_2 recorders will aid greatly in the obtaining of large savings in fuel consumption.

One of the largest losses in the boiler room is due to excess air supplied to the furnace. The excess air should be reduced to the lowest possible figure. Even 50 per cent, so often regarded as a working limit, is more than is needed, and with proper furnace design, 10 per cent. is ample. The design of the combustion space is important, as it affects the incomplete combustion loss. Heating surface exposed to direct radiation from the fire serves to keep the furnace temperature lower than otherwise, and increases the efficiency of the boiler and setting, both of which are valuable results.

The heat loss carried away in the flue gases, due to their high temperature, is often very serious. Especially at high loads does this become noticeable. Boilers can be operated at twice their rating, and more, but not economically unless they are designed for such conditions. Reduction of flue-gas temperatures is possible in most cases by reducing excess air, increasing velocity, eliminating dead-gas spaces, re-baffling or installing auxiliary baffles, exposing some of the heating surface to direct radiation from the fuel bed, and last, but not least, maintaining clean heating surfaces by blowing with steam at regular intervals and scraping the heating surfaces when the boiler is down for cleaning.

Boiler-plant efficiency can be considerably increased by adding economizers. The chief reason they are not more used is that their value is not realized. Much depends upon properly proportioning the installation, and the governing factors must be carefully studied, e. g., gas and water temperatures, weight of air per

pound of coal, load factor, etc. While economizers do reduce the draft available at the boiler, much of the total loss is often due to leakage in the gas passages. If the economizer forces the use of mechanical draft, the saving is reduced somewhat, but there is an offsetting gain due to the possibility of carrying thicker fuel beds securing more efficient combustion.

Much heat is wasted by dirty boilers, and the cost of cleaning boilers in most plants is considerable. The use of distilled water, or the proper treatment of feed water, should be given more attention. Not only economy in fuel, but the cost of cleaning and repairs, the life of the boiler, and the safety of the installation depend upon this.

Preheating of furnace air with the heat in the escaping flue gases would save considerable, but is never practiced. A saving of five per cent. is easily possible, and air preheaters to effect this saving could be constructed cheaply.

The economy of auxiliaries should be given more attention. Throttling engines and direct-acting steam pumps should be eliminated wherever possible, and small motor or turbine driven units installed in their places, unless the exhaust steam is all utilized in feed-water heaters, or otherwise.

The use of high pressure steam in manufacturing processes should be discouraged. Reduction of pressure through turbines or engines will usually result in a saving without materially reducing the heating qualities of the steam.

The value of exhaust steam for heating and the consequent saving effected has been demonstrated, and many plants take advantage of it, but the practice should be more general.

About the most wasteful plants are the ice-making and refrigerating plants. All except the very small ones and those near coal mines, should be making ten tons of ice per ton of coal burned, and in no case less than six tons. One reason for the existing bad conditions is the low load factor. Another source of loss is, as already noted, in the boiler room. Distilled-water ice is often made, although raw water ice can be made just as well, and with a great saving. In extreme cases where distillation is necessary, multiple effects may be used with excellent results. Often the plant operators do not understand the physical laws underlying mechanical refrigeration, and as a result operate the plant in an uneconomical manner. The use of exhaust steam in an absorption plant would often result in large savings.

The economy of the prime mover is important to the power plant. Among the types worthy of study may be mentioned the uniflow engine, the locomobile engine, the exhaust steam turbine, producer-gas plants, gas engines, and the Diesel engine. Superheating the steam may often lead to marked gains. The burning of oil and gas under steam boilers should be discouraged, since these fuels are much more economically used in gas and heavy oil engines.

The article gives several figures showing economies of various types of prime movers, and of boilers under various conditions.

To obtain the greatest efficiency possible in a power plant is not only a matter of design, but a good deal depends upon proper operation and management. The men must be made more efficient through education, supervision, a bonus system of payment, competition and advancement, and welfare work.

In the matter of smoke prevention, much harm is done by overlooking the loss due to excess air. Mere prevention of smoke may result in serious heat losses if this latter item is not carefully controlled. Education along these lines is sorely needed. Much has been done, but not sufficient to reach more than a very small proportion of the firemen of the country.

Reading-rooms for employees, literature available for their use at home, meetings between foremen and employees, lectures on technical subjects, will all tend to better and more efficient operation. Absolute strictness and discipline should be maintained and, at the same time, if the men do the proper amount of work, they should receive the right compensation for it. Proper washing facilities should be provided, and the man enabled to live in suitable quarters. Competition between plants may prove a valuable stimulus, and, when practical, a bonus system will add to its value.

It was the author's aim to outline in this paper the existing weak points and to expose the wasteful conditions, whose prevention is not only our duty, but also for our immediate benefit. A nation-wide campiagn should be started and persistently carried out until results are obtained.

The Talbot Boiler. By Paul A. Talbot. **Journal of A. S. M. E.,** December, 1916.

This paper describes a new form of water tube boiler, in which the circulation is forced at high velocity by means of a pump. It is an internally fired boiler, in which the supply of feed water and fuel are automatically controlled to adjust the boiler to large variations in the demands for steam.

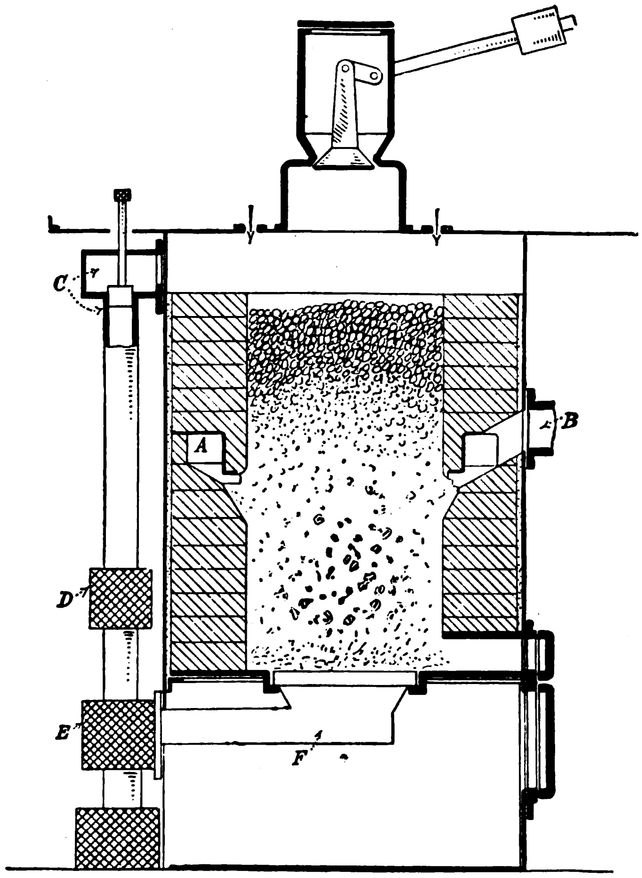
Any tube may be readily removed, and the author states that during a recent test in the New York Navy Yard, a tube was replaced by another one with a total time of only three minutes and sixteen seconds from the shutting off of the fire and feed water until the full pressure was again regained.

It is claimed that the formation of scale is prevented by the high velocity of the water in the tubes. This velocity is about 500 ft. per min. in the first set of tubes and increases, due to the formation of steam, until a value of about 12,000 ft. per minute is reached in the last set of tubes. This high velocity of the water also tends to produce a high rate of evaporation.

The article states that the efficiency of this type of boiler is affected by "forcing" in much the same manner as are other types. Unfortunately no values of the efficiencies are given in the abstract contained in the December Journal.

A Gas Producer for Bituminous Fuel. By O. C. Verry in **A. S. M. E. Journal** for December, 1916.

The special problem in the design of a producer for bituminous fuel is to provide for the elimination of the tar either in the producer itself or in a special tar extractor separate from the producer. If the tar is disposed of in the producer itself a chemical change takes place and the H-C's of which the tar is made up are split up into simpler H-C's or are completely burned to CO_2 and H_2O. The multiple expansion producer, the down-draft producer, and the recirculating producer are all examples of this type of apparatus. The author has developed a type of recirculating producer shown in the accompanying illustration.



The operation is as follows: Coal is fed in at the top, air enters at the bottom. The products of distillation and the other recirculated gases are drawn into the pipe C by the steam blower D. The gases are then delivered into the header E thence to the distributor F which really distributes the gases to the entire grate area. The recirculated gases burn to CO_2 and H_2O and in passing upward through the incandescent zone are reduced to CO and H_2 which collecting in the annular space A, passes out through B. Tests on the producer while yet incomplete show no tar in the resulting gas.

The producer above described is a modification of the Whitfield Recirculating Producer. The author carried on special investigations in Purdue and Wisconsin Universities for the purpose of determining details of blower operation and the proper temperatures to use thruout the equipment. The apparatus used in this work is described and illustrated, and the results of his experiments are briefly stated.

In closing, the shortcomings of the down-draft and the double combustion zone producers are noted and the methods for correcting these difficulties in the new producer are given.

Standardization of Machine Tools. By Carl G. Barth. December Issue, **Journal A. S. M. E.**

To meet the requirements of more efficient shop management Mr. Barth urges upon Machine Tool Builders the adoption of a standard speed series, a standard feed series, a standard tool post for lathes, standard T-slots, and a standard taper for lathe centers and for drill and milling machine sockets. After much experience in the work of installing the Taylor system of Shop Management in various shops and works these standards are felt by Mr. Barth to be essential to economy and simplicity.

It is practically accepted, or should be, that all machine tools of the general purpose type having a revolving spindle carrying the work or the tool should have a speed series in geometric progression. The author after discussing several progression factors as a basis for such a series advocates $\sqrt[2]{2}$ as a suitable and desirable factor. The resulting speed series would be.

1	$\sqrt[4]{2}$	$\sqrt[4]{4}$	$\sqrt[4]{8}$	$\sqrt[4]{16}$	$\sqrt[4]{32}$	$\sqrt[4]{64}$	etc.
1	1.1892	1.4142	1.6818	2	2.3784	2.8284	etc.

Where a series of larger steps is found desirable it is recommended that every other term in the above series be omitted giving.

1	$\sqrt[4]{4}$	$\sqrt[4]{16}$	$\sqrt[4]{64}$	etc.
1	1.4142	2	2.8284	etc.

What has been said concerning the speed series holds equally true for the feed series except for the more up-to-date lathes having the feeds for plain turning as a constant fraction of the screw cutting feeds. For these it is recommended that the cross as well as the longitudinal feeds be made the same fraction of the screw cutting feeds regardless of the size of the lathe.

The desirability of standard T-slots and bolts is discussed and proportions, based upon investigations and the author's experience, are given. Likewise proportions are proposed and given for tool posts for lathes, the proportions being the result of the author's experience and his intimate familiarity with On the Art of Cutting Metals.

As a standard taper for lathe centers and for dill press and milling machine sockets the Brown and Sharpe standard is recommended, it being also recommended that taper shanks be grooved and driven by means of a key instead of the old style tang. For the purpose a special key,—the Barth key—is recommended and proportions given.

Electrical Distribution in Denver. Electrical World, Dec. 9, 1916.

This city has followed the lead of the Chicago Edison, and some of the other large distributing companies, in that the existing 3-wire, single phase and three phase,

2300 volt system, which has been used for years has been converted into a 4-wire, 3-phase, 4000 volt system, with a voltage of 2300 between the line wires and the neutral. This increase in voltage has been obtained by a rearrangement of the existing plant, and has allowed the system to grow and extend over a wider area, due to what is really a 70% increase in operating voltage.

Central Station Heating Supply, in the **National Engineer** for December, 1916, is an account of a report by a committee of the National Electric Light Association, working in conjunction with a committee of the National District Heating Association. Their object was to study the problem of relieving the mill owner of the factory heating problem by central station operation of the heating plant on the customer's premises, or otherwise.

The cost of operating a plant supplying both steam and electric service depends on the co-ordination of the two, the saving that results from running them together depending on the character of the industry, the working hours, and the weather conditions. In the case of an isolated plant, both services are furnished from a single plant, which enables certain economies to be obtained, the chief of which is the duplicate use of the steam for power and heat. In the case of central station service, the electric service is furnished by the central station, and steam service by a local steam plant. This prevents the obtaining of certain economies, but, on the other hand, the central station costs for its own coal, and its own big and efficient stations, make the price for central station electricity so much lower than the isolated plant costs that the net result is often a much lower total cost for central station than for isolated plant operation.

Isolated plant owners are usually willing to put up with some inconveniences in view of their independence, and their interest in the problem concerns total costs for heat, light, and power. Unless the prices of central station service are low enough, isolated plant operation may be really cheaper. For a central station advertiser or salesman to claim broadly that central station service is always cheapest in the end is as foolish as for a consulting engineer to tell his client that the isolated plant will surely be better than central station service.

If the customer is not convinced by the figures the lighting company presents purporting to show that he will save money to abandon his local equipment and keep merely a low pressure boiler for factory heating in winter, then a central station may take the contract for heating his factory at a guaranteed expense to the customer.

The committee seriously talks about the central station having a "steam heating department" and actually doing the work of heating the premises of customers who buy their electric power and light of the lighting company. Since this work is really to help tip the scale toward factory adoption of central station drive, it may be regarded as an adjunct to the sales department and be conducted profitably at a loss!

It does not seem advisable at the present time for central stations to enter into a general heating business, but we believe that it is desirable to enter into a limited number of contracts in order to secure the sale of additional electricity.

The heating value of oil is very much higher than the value of coal. Furthermore, a higher efficiency can be obtained with oil just as it is possible to obtain a higher efficiency with good coal than it is with poor coal. It is well known that with a poor grade of coal containing only 10,000 B. t. u. a boiler efficiency of 60 per cent. is all that can be expected whereas with the best coal having 15,000 B. t. u. an efficiency of 75 per cent. can be obtained. With oil it is a simple matter to obtain an efficiency of 78 per cent. in regular plant operation.

Mechanical Refrigeration, by Thomas G. Thurston, in **The National Engineer** for December, 1916.

The article discusses in some detail the operation of a direct expansion system having several expansion coils of different sizes operating in rooms maintained at different temperatures. Attention is called to the fact that the expansion and suction valves on each coil must be so adjusted that the coil is kept filled with liquid and that the suction pressure is kept as high as possible.

For steady operating conditions, the condenser pressure, should be held as nearly constant as possible to avoid the necessity of frequent readjustment of the expansion valves. For various reasons, the condenser pressure should be kept as low as possible. This involves using the coldest available water in the condenser, and keeping air and other foreign gases out of the system. To this end, vacuum should be avoided in the system, and the compressor should not be allowed to run at high temperature, since this may vaporize the lubricating oil, and discharge explosive vapors into the ammonia system.

Since the heat of vaporization of CO_2 is much smaller than that of ammonia, the loss of capacity due to the heat of the liquid entering the expansion valve is a much greater proportion of the total refrigerating effect available. However, the CO_2 system has such advantages at other points that its operating efficiency, under favorable conditions, may be as good as that of the ammonia plant.

Oil Engine Performance. The National Engineer for December, 1916, states that a case is reported in a southern state where an oil engine driving a refrigerating machine operated continuously for 11 months.

The National Engineer for December, 1916, quotes Mr. Frank H. Varney, chief engineer of operation and maintenance of the Pacific Coast Gas & Electric Company, on the subject of the use of **Oil Fuel** in boiler furnaces. He discusses the design of furnaces and the location of the burners. Concerning the operation of the oil burning furnaces, he says that the oil on reaching the boiler room is heated to a temperature of approximately 180 deg., and is delivered to the burners at this temperature and at a pressure of 40 to 50 lb. The oil is

atomized in practically all power plants by steam. While compressed air may be used for atomizing, it is found that the quantity of steam used is so slight as to make the installation of an air compressor unprofitable. In normal operation it is customary to use about 3 or 4 per cent. of the steam for atomizing, but by proper care in heating the oil and in the design of the burners and furnace, it is possible to reduce this to less than 1 per cent.

Installation of Farm Lighting Plants, Electrical Review and Western Electrician, Dec. 2, 1916.

In order that the "Back to the Farm" movement may become more interesting to the people who have flocked to the cities, farm life must be made as comfortable and convenient as life in the city, and electric light to-day is recognized as one of the essentials on a modern farm.

The automobile, the telephone and the rural free delivery have all played their part, and the farmers, who are now making more money for the same amount of time and energy as many other class of men, are able to and are desirous of putting in electrical equipment.

The distance over which power must be transmitted from transmission lines, in order to supply the farm consumers, makes the proposition not very attractive for the central station, and isolated plants have become necessary. Many farmers to-day having had experience with modern automobiles, equipped with self-starters, electric lights and storage batteries, have the necessary experience for operating an up-to-date farm lighting plant, and there is to-day a demand for a plant not too highly automatic, consisting of a gasoline engine direct connected to a generator of from .75 to 1.5 kilowatts at 32 volts, and connected to a good 160 ampere hour storage battery. Such a plant would operate a churn, cream separator, electric iron, washing machine, suction pump and 40 light installation.

Individual Motor Drive for Flotation Machines. Article by E. Shores and editorial introduction, **The Electric Journal,** December, 1916.

It is an experimental fact that finely pulverized metal-bearing ores cling to the surfaces of oily or soapy bubbles. This fact is utilized in concentrating low grade ores: bubbles are produced as a froth or foam, in the presence of crushed ore; and they accumulate the metal-bearing ore, which can then be worked at a profit where it would not otherwise be worth working. This accumulating process is called flotation.

The foam is produced by agitation, in any one of a number of ways. In the Janney cell which is discussed by the author it is produced by agitating paddles driven by a vertical-shaft motor, revolving at about 600 r.p.m. The rotating member consists of the rotor of the motor, the shaft and paddles. At the top of the motor, supporting the rotating member, is a step bearing, which is a ball-bearing, flooded with oil. Below the motor but above the paddles is a heavy guide bearing, preventing excessive vibration. The motors are not described fully by the author, but it is evident that 10 h.p. squirrel-cage induction motors are used in the installation that is described.

The advantages of individual motor drive for this purpose are:

Avoidance of the dangers of shafts and belts.

Complete control over each individual cell without the necessity of a loose pulley.

Saving of the steel structure for supporting shafting.

Saving of power otherwise lost in friction of shafting.

Avoidance of most of the delay due to shut-down of the driving motors, because only one cell is shut-down at a time. This is of the greatest importance with Janney machines, on account of the delay in making adjustments after a shut-down.

Saving in space by setting machines closer together than they could be if belt-driven.

Set over against these advantages are of course the extra first cost per horsepower and the lower efficiency of small individual motors, but the total first cost including steel structure is about the same in either case. The other advantages of individual drive far outweigh those of group drive.

The Partition of the Load in Riveted Joints, by Cyril Batho; **Journal of the Franklin Institute,** November, 1916.

A method is presented for determining, by application of the principle of least work, the proportion of the total load carried by each row of rivets in a joint.

An account is given of the experimental verification of the mathematical analysis for one type of joint.

The tests were made on butt joints with double cover plates and with rivets arranged in a single line parallel to the axis of the load. Strains were measured by mirror extensometers reading accurately to $\frac{1}{100,000}$ inch, with a gauge length of two inches.

A short summary of the results follows:

(1) The computed load distribution was closely checked by the experiments.

(2) Rivets appear to act in shear rather than by inducing friction of the plates. If this latter exists it is confined to the immediate neighborhood of the rivets.

(3) In a joint of the type tested, the end rivet and the one nearest the junction of the middle plates take "by far the greater portion of the load at all loads within that causing permanent deformation." This condition can not be remedied by increasing the number of rows. of rivets. With 3 rivets the intermediate rivet takes 0.2 of the load on the joint; but when the number of rivets is increased to 8 (in a line parallel to the load), the 6 intermediate rivets combined carry only 0.268 of the total load.

The Lubrication of Bearings is the subject of an article in **The American Machinist** of November 16, 1916, by William Knight of the Crocker-Wheeler Co.

"Our knowledge of the laws of lubrication of bearings is quite recent, and is yet far from being complete. We know, from a number of experiments already made, some of the relations that exist between the several phy-

sical factors affecting the coefficient of friction and load-carrying powers of a lubricated bearing, but more experiments are needed before we will be able to establish a rational basis for bearing design."

Reference is made to the necessity of having future experiments conducted along definite lines, in order to gain the knowledge we need, and a paper referred to by M. D. Hersey, "On the Laws of Lubrication of Journal Bearings," presented at the meeting of the A. S. M. E., June, 1915, of which a good recapitulation is given in an editorial in **The American Machinist**, Vol. 43, page 81.

Other recent investiagtions are cited including an article by Professor Upton, in THE SIBLEY JOURNAL OF ENGINEERING, 1916, in which an analysis of the conditions affecting the thickness of the oil film and its influence on the lubrication of bearings, is given.

He continues with a brief survey of the main principles established in the laws of lubrication of journal bearings derived from the first classical experiments made by Beauchamp Tower (see "Transactions" of the British Institution, 1885), followed by the mathematical analysis of bearing lubrication of Professor Reynolds (see "Philosophical Transactions," Vol. 177) and the experiments of O. Lasche, of Berlin (English translation in "Traction and Transmission," London, 1903). Mr. Illmer (see **Power,** Feb. 22, 1916) gives a complete comparative analysis of the results obtained by different experiments and derives from them some useful designing formulas giving the coefficient of friction and load-carrying power of journal bearings, which are given in an abstracted form.

Some still more recent experiments made by Messrs. Thomas, Maurer and Kelso (see "Proceedings" of the A. S. M. E., 1913) on lineshaft bearings have furnished us some sort of connecting link between Tower's and Lasche's experiments on bearings heavily loaded and the conditions that we have in the actual service of bearings subjected to moderate loads.

Formulas are given for coefficient of friction, bearing pressure, rubbing velocity, heat removed, cooling water required, temperature rise, horse power and specific loss. The author concludes the article with the opinion that in the case of a ring-oiled bearing properly designed, constructed and lubricated we have as good an oil film as in the case of forced lubrication.

A series of articles dealing with **the plants of the Remington Arms Co.,** begin with the Nov. 23, 1916 issue of **The American Machinist.**

The largest concern for rifle manufacture in the United States is the Remington Arms Co., operating two plants having a combined capacity of 8,000 guns per day. To meet the war orders now being filled, factory buildings containing more than 2,000,000 sq. ft. of floor area have been completed within a year. The first article takes up the general construction features of both plants and is devoted to a discussion of the type of building adopted, the walls, floors, supports for overhead fixtures, provisions for fire protection, etc.

PERSONALS

A. W. Wakely, '11, is with John Burnham & Co., investment bankers and underwriters, La Salle and Monroe Streets, Chicago.

Tell S. Berna, '12, is soon to marry Miss Katherine Wilby of Cincinnati, Ohio. Berna is in the Cincinnati office of the Cutler-Hammer Mfg. Co., 812 Gwynne Building.

G. T. Morris, '12, has been appointed fourth assistant examiner in the U. S. Patent Office. He was formerly connected with the Bureau of Standards. His address is 2625 Garfield Street, N. W., Washington, D. C.

Horace B. Nye, '12, has recently changed his address to Box 27, Woonsocket, Rhode Island. He is electric engineer with the Power Construction Company of Worcester, Mass.

W. H. Stevens, x'12, has formed a partnership with R. R. Meigs, to conduct a consulting practice in mechanical and electrical engineering, with offices at 1001 Chestnut Street, Philadelphia, Pa.

George M. Curtin, '13, was married to Miss Laura C. Potter, of Gloversville, N. Y., on October 4th.

C. C. Hope, '13, has resigned his position with Dodge Brothers to enter the service department of the Scripps-Booth Company, Detroit.

S. D. Mills, '13, 301 West Grand Ave., Oklahoma City, is manager of the bond and casualty department of the Fidelity & Deposit Company of Maryland, with Merrill & Braniff, general agents at Oklahoma City.

Sterling W. Mudge, '13, of Glen Cove, N. Y., has recently become an instructor in the mechanical laboratories of Pratt Institute, Brooklyn, New York.

Donald H. Reeves, '13, was married to Miss Anna S. Chrisman, A.B., '15, at West Chester, Pa., on September 18. The home of Mr. and Mrs. Reeves is at 1232 John R. Street, Detroit.

Ambrose Ryder, '13, has been transferred from the St. Louis branch of the Workmen's Compensation Service Bureau, to their main office, 13 Park Row, New York City.

Jessel S. Whyte, '13, is the father of a daughter, Harriet Louise, born on September 21. Whyte and his family are living at Kenosha, Wis.

W. Howard Zabriskie, '13, until recently foreman of the Standard Oil Company of New York, Long Island City, N. Y., has become affiliated with the Standard Oil Company of California, Richmond, Cal.

The following Sibley men are employed by the New York Telephone Company and are working in their engineering department at 195 Broadway, New York City: **B. K. Boyce, '07; J. E. Brewrink, '07; A. L. Richey, '11; F. F. Addicks, '13; F. Rhinehardt, '13.**

Leo J. Brennan, '14, is in the experimental department of the Standard Underground Cable Company. His address is 228 High Street, Perth Amboy, N. J.

Albert T. Avery, '14, was married to Miss Rachel White, of Groton, Connecticut, on September 12.

Jen Chow, '14, is making plans for a newspaper publishing house in Shanghai.

T. F. Fowler, '14, 43 Kingsbury Place, is assistant sales manager of the Chevrolet Motor Company of St. Louis, Mo.

D. H. Gleason, '14, who was with the New London Shipbuilding Company, is now in the Cartridge department of the Winchester Repeating Arms Company of New Haven, Conn.

A. W. Keller, '14, having left the Eastman Kodak Company of Rochester, N. Y., is now with Richards & Company, Stamford, Conn., as experimental chemical engineer in the manufacture of artificial leather.

Charles R. Vose, '14, assistant secretary of the Compensation Inspection Rating Board, 135 William Street, New York, has changed his address to 87 Post Avenue, New York, Apartment 53.

Arthur S. Wells, '14, is with John A. Stevens, engineer, Lowell, Mass.

Joseph A. Cook, '15, has moved from Dunkirk, N. Y., to 179 Peterboro Street, Detroit, Mich. He is with the United States Radiator Corporation.

F. G. Dennison, '15, has left the Remington Arms & Ammunition Company. He is now in the production department of the Bridge Brass Company. His address is 70 Ford Place, Bridgeport, Conn.

Perry T. Egbert, '15, is employed by the Norfolk & Western Railroad. His address is Y. M. C. A., Roanoke, Va.

Paul W. Fenton, '15, of New York City, has returned to Ithaca to take some graduate work in chemistry. He is instructing in Sophomore machine design.

Leonard Foote, x'15, is in Paraiso, Panama, Canal Zone, working for the U.S. Panama Canal Commission.

Wray B. Hoffman, '15, and **Charles P. Hubbard, '15,** are employed by the Wheeler Condenser Company, of Philadelphia, Pa. Hoffman and **Clarence T. Keet, '15,** live at 513 East Chelton Avenue, Germantown, Pa.

John J. Matson, '15, a student engineer with the General Electric Company, lives at 1003 Nott Street, Schenectady, N. Y.

D. T. Stanton, '15, is with Dodge Brothers, Detroit, Mich.

Douglas B. Wright, '15, formerly connected with the steam and chemical testing department of the Philadelphia Electric Company, Philadelphia, Pa., has accepted the position of test engineer in the steam engineering department of the Worth Brothers' Company of Coatesville, Pa.

Robert S. Bassett, '16, is employed by the Buffalo Meter Company. Home address: 691 West Ferry Street, Buffalo, N. Y.

H. A. Cahen, '16, has taken a position in the testing department of the Standard Underground Cable Company.

R. C. Davis, '16, is working for the Remington Arms Company of New Haven, Conn.

Andrew Hale, '16, of 45 Rhodes Ave., Akron Ohio, is in the employ of the Miller Rubber Company, of Akron.

E. N. Holstrum, '16, has taken a position with the Wagner Electric Company in St. Louis.

Otto D. Lorenzi, '16, is with the Combustion Engineering Corporation, 11 Broadway, New York City.

J. Frank Naugle, '16, is with the Michigan Inspection Bureau, 510 Farwell Building, Detroit.

John H. Vohr, '16, is in the traffic department of the New York State Railroads at Syracuse, N. Y.

H. B. Cushman, F. T. Estabrook, J. W. Gale, and **M. W. Wiesner,** all 1916 men, are working for the German-American Button Company in Rochester, N. Y.

These 1916 Sibley men have their headquarters in the Telephone and Telegraph Building, 195 Broadway, New York City: **L. R. Grumman** and **R. J. Wightman** New York Telephone Company; **J. H. Moore,** American T. & T. Company; **H. P. Corwith,** and **W. V. McGuinness,** Western Union and **C. L. Funnell,** Western Union.

Professor Dexter S. Kimball is one of the members of the A. S. M. E. committee on Student Prizes.

Ben Johnson, '78, is superintendent of motive power of the United Railways of Havana, Cienaga, Havana, Cuba.

Charles J. Barr, '93, formerly general superintendent of the Tennessee Coal, Iron & Railroad Company at Ensley, Ala., is now with the Algona Steel Company, Sault Ste. Marie, Ontario, Can.

W. S. Stothoff, '97, has recently been appointed general superintendent of Wm. Wharton, Jr., & Co., Inc., Easton, Pa., and the Tioga Steel and Iron Company, Philadelphia, Pa., in charge of plants and manufacturing. Formerly he was in charge of sales for the Taylor-Wharton Iron and Steel Company, the parent company, at Highbridge, N. J.

H. L. Terwilliger, '97, is district manager for the Ingersoll-Rand Company, with headquarters in the Rialto Building, San Francisco. His address is 575 Embarcadero Street, Palo Alto, Cal.

Julius I. Wile, '97, is representing the Permutit Company, with headquarters at 30 East 42d St., New York City.

Norman J. Gould, '99, of Seneca Falls, was one of three Cornellians re-elected to the national House of Representatives from New York. Gould represents the 36th district.

Norman D. Betts, '03, has left his research work in the forest products laboratory of the U. S. Forest Service, at Madison, Wis., to start ranching. His post office address is Linwood, Unitah County, Utah.

Thomas S. Ramsdell, '03, engineer for the Monument Mills, manufacturers of cotton, Housantonic, Mass., has just begun the construction of a large hydroelectric and steam power station, of his own design, for the company.

Continued on page 116

BOOK REVIEWS

Steam Power. By C. F. Hirshfeld and T. C. Ulbricht. viii + 420 pages, 5½ by 8. 228 figures. N. Y., John Wiley & Sons, 1916, Cloth, $2.00, net.

In this brief treatise, the authors, both former members of the Sibley faculty, have given us a comprehensive, yet simple, discussion of the operation of steam power plant apparatus, together with the development of a simple, common-sense view of thermodynamic processes. The treatment is from the physical rather than the mathematical point of view, and a reader trained in elementary algebra should have no difficulty in grasping such mathematical statements as are included.

The authors state that they have written the book as a text for courses in steam power given to civil engineering students, and for similar courses in industrial and trade schools. It seems to the writer that the book is not well suited for the first class of students, since courses in civil engineering always include training in mathematics and physics, enabling students to understand a thorough treatment of thermodynamic theory, which will serve as a basis for a more complete discussion of many phenomena. Further, civil engineers are interested in gas power and air compression, as well as steam power. For the industrial school, however, the book seems splendidly adapted. It avoids abstruse theoretical discussions, and yet does not fail to build up a sound and thoroughly rational view of the topics discussed. Exact theory and complex mathematical expressions are omitted for the sake of simplicity, but the statements as given are in harmony with up-to-date theory, so that the student is not led to hold antiquated or incorrect views. Should he desire to study further, he will not have to waste time un-learning his earlier work.

In the initial discussion of the properties of steam, no mention is made of either entropy or intrinsic energy. Two later chapters take up the use of the temperature-entropy diagram for steam, and the study of the Rankine cycle with its aid. No attempt is made to define the meaning of entropy, and thus half-truths and false conceptions are avoided. The properties of entropy are stated as needed, and a correct knowledge of its use should result from careful study of these two chapters. The concept of intrinsic energy is not introduced anywhere in the book, although it is hinted at in the discussion of the properties of steam. This omission simplifies the work, but at the same time restricts its usefulness to some extent. It seems to the writer that this quantity would be a sufficiently useful addition to make its introduction well worth the space required.

There is an excellent treatment of the action of steam in real engines, together with a description of the structural features of the usual types of engines. An entire chapter is devoted to the compound engine, and another to the indicator and its use in the analysis of engine operation. The slide-valve is discussed with the aid of the Bilgram diagram, and a chapter is given to the consideration of the Corliss and other "high-efficiency" types of engines. Governing is discussed briefly.

The steam turbine and condenser are next taken up, and are discussed in detail. The theory of their operation is covered fully, and the common types are described, with numerous illustrations. The design of steam nozzles, the relations of jet and bucket velocities, the measurement of vacuum, and the reduction of such readings to absolute pressures, are all well treated.

The chapter on combustion presents clearly the elementary chemical relations and notation, and continues with a study of the combustion of carbon, sulphur, and hydrogen, with both weight and volume relations developed for pure oxygen and for air as the supporter of combustion. The composition of flue gases is discussed in the light of these chemical relations, and a reader should gain a good fundamental understanding of the interpretation of flue gas analyses. This chapter is followed by a brief discussion of the more common fuels and their composition.

The chapter on steam boilers devotes much space to an excellent treatment of the very important subject of furnace operation as influencing fuel economy. Mechanical stokers, and various types of boilers and settings are shown and discussed in relation to various grades of fuel. The effects of soot and scale are mentioned, with various remedies treated briefly. After a section on superheaters, the chapter closes with a short treatment of draft and the proportioning of chimneys.

The final chapter describes briefly the operation of pumps, injectors, separators, and steam traps. The important items in connection with the design and construction of piping are enumerated.

At the end of the book is a steam table, and also an excellent index, covering twenty pages, which should add greatly to the reference value of this volume.

Another very commendable feature of the book is the use of numerous illustrative examples, worked out in full detail, to make more clear the methods of computing numerical results. These examples should prove very helpful, especially to beginners and those who have grown rusty in their mathematics.

The book is illustrated by many cuts and diagrams, which are very well chosen, and, for the most part, well drawn.

On the whole, we have here a brief treatment of a single phase of technical thermodynamics which should prove of great value to those interested in training themselves or others in matters relating to the generation and use of steam for power purposes, and who desire to find a book which assumes little beside the "common-sense" knowledge of an ordinarily observant person.

UNIVERSITY NOTES

The resignation of Professor George Sylvanus Moler, of the department of physics, was accepted by the Board of Trustees on November 11. Professor Moler will retire from teaching in June, 1917, he having reached the age limit. During the twelve years he and Professor Anthony shared the entire duties of the department, the two, in collaboration, designed, constructed, and installed the first dynamo in America, the first arc-lighting system (that on the university campus), and the first apparatus for the electrolytic production of oxygen and hydrogen on a large scale. He has also devised and originated many pieces of apparatus of inestimable value to the department of physics. Professor Moler is held in high esteem and grateful remembrance by students of many generations. He was graduated from Cornell University in 1875 with the degree of B.M.E.

First Lieutenant George R. Harrison, U. S. A., has been detailed as professor of military science and tactics at Cornell University. There are now two such professorships in the university, the senior officer being Captain Charles F. Thompson, U. S. A. Under the newly inaugurated system, the cadet corps will have five regular army officers, that is, one for every four hundred cadets.

The College of Agriculture again won the intercollege cross country championship, as a result of the meet held on Saturday, November 25, beating Sibley, who was second, by 54 points. This margin was smaller by nearly 50 points than that of last year. The scores of the different colleges were as follows: Ag., 74; M.E., 128; C.E., 171; Vet., 288; Chem., 291; Arts, 337. Tinnerholm, of the College of Agriculture, was the individual winner of the meet, while Lentz, a Sibley man, was a close second. The Sibley men finished in the following places: 2, 6, 17, 20, 21, 29, 33.

Practically all that is necessary for the completion of the new university observatory, which is located on the north bank of Beebe Lake, is the installation of the instruments and the work on the dome and roof. The building is 87 feet long and 18 feet wide, with a center section wide enough to accommodate the 24-foot dome, which will contain a twelve-inch equatorial telescope. It is expected to be ready for use at the beginning of the second term.

Twenty-five seniors and one junior were elected this term to Tau Beta Pi, the honorary engineering society, as a result of the annual fall election last month. Eighteen of these are Sibley men, four of whom are studying electrical engineering, five are from the College of Civil Engineering, two from the Department of Chemistry, and one from the College of Architecture, these being the only colleges whose men are eligible to Tau Beta Pi.

Dean Smith has appointed a committee consisting of Assistant Professors C. H. Berry, J. G. Pertsch, and Mr. P. G. McVetty, to arrange for a series of lectures by non-residents during the year. The new motion picture machine which has been installed in Sibley Dome will be used to illustrate some of these lectures. Two film lectures have so far been given, one on "The history of the typewriter" and "The evolution of the stenographer" and the other on "The manufacture of steel pipe and tubes."

The Board of Trustees has appointed a committee to consider the advisability of raising the tuition fee to $150 in every college in which it is less than that at the present time. This fee is $100 in the veterinary college, and $125 in the Colleges of Arts and Sciences, Law, and Agriculture. In the other colleges it is $150. This contemplated increase would not affect residents of New York State who are registered in the agricultural and veterinary courses, for tuition is free to such students.

The first meeting of the Cornell branch of the A. S. M. E. was held on November 13. In his introductory talk, Professor Carpenter, chairman of the branch, outlined the aims of the society and the advantages to be gained from membership therein. In brief it may be said that the society brings the student into more intimate contact with engineering practice as it is today, this being done by having prominent engineers discuss the important engineering topics of the day.

The speaker of the evening was Professor Jacoby of the College of Civil Engineering at Cornell, who explained the fall of the Quebec bridge. Professor Jacoby, who is an authority on bridge design, emphasized the fact that the disaster was not due to any negligence on the part of the engineers in charge, but rather that the science of engineering was not far enough advanced to insure their success. Never before had such a gigantic task been attempted—they had no precedent to follow so that at best their success was only probable.

The officers of the branch for the present year are: hon. chairman, Professor Carpenter; president, W. C. Bliss, '17; vice-president, R. O. Compton, '17; secretary, S. M. Barr, '17; treasurer, W. W. Robertson, '17.

The society extends to all a cordial invitation to attend the meetings and promises an interesting and instructive evening.

At a meeting of the Ithaca Section of the American Institute of Electrical Engineers, early this fall, the following changes were made in the officers for the current year: Prof. E. L. Nichols resigned as chairman of the local section, Prof. Frederick Bedell being elected to fill the vacancy thus left. Prof. Gray and Prof. Karapetoff were chosen to serve on the executive committee. William Deans of the Department of Electrical Engineering was chosen secretary of the Section. Prof. Karapetoff was elected chairman of the Program Committee.

The first open meeting of the year was held in Franklin Hall on October 27th. J. F. Putnam of the Department of Electrical Engineering spoke on "Some Problems of the Research Laboratory of a Large Public Service Corporation." His talk was a resumé of his personal experiences while in charge of the research laboratory of the Rochester Railway Company. In the same meeting, William C. Ballard, of the Department of Electrical Engineering, had as his subject "Recent Advances in Radio-Communication," in which he outlined the late improvements in sending stations, and in particular the late developments of the generator for radio work.

Mr. E. F. Alexanderson, consulting engineer for the General Electric Company, addressed the section at their second meeting, held November 17th in Franklin Hall, having for his subject "Large Single-Phase Loads from Three-phase Stations." Mr. Alexanderson described his late invention, the phase-converter, taking the matter up from several different points of view. He showed how, by the use of his apparatus, it is possible to take from a three-phase station a large single-phase load, and yet maintain balanced conditions so far as the load upon the generators is concerned.

The greater interest evidenced by the student body and the public in the meetings of the Institute this year, promises a year of activity.

OBITUARY

John Whipple Hill, '73

John Whipple Hill, B.M.E., '73, died at Chicago on November 12, 1916, after a six months' illness. He was born October 3, 1851, at Rome, N. Y. He received his early education at the Rome Academy. In 1869 he entered Cornell University to study engineering, and while here was quite popular. In his sophomore year he was elected vice-president of his class. For two years he was treasurer of the baseball club, becoming its president in his senior year. During his last year he also held the office of treasurer of the Navy. He was a member of the Chi Phi fraternity, a club known as the Dagger and Serpent, and the Delta Alpha class society.

Immediately after graduation he was in business in Minnesota, later in New Mexico, and at the time of his death, was with Armour & Company, of Chicago, with whom he had been identified since 1888.

Mr. Hill, always an ardent and enthusiastic Cornellian, took an active interest in the Cornell alumni association of Chicago, of which he was the president in 1897.

He is survived by his wife, whom he married in 1897, and he leaves two brothers, William S. Hill, '77, of New York, and Henry B. Hill, '80, of Faribault, Minn.

Harry Disbrow Johnson, Jr., '04

Harry Disbrow Johnson, Jr., '04, died on November 14, at his home in South Bend, Indiana, of typhoid fever.

Mr. Johnson was born at South Bend on July 29, 1882. He was a member of the Class of 1904 in Sibley College. For two years after leaving college he was employed by the General Electric Company at Schenectady, N. Y. In 1906 he returned to South Bend and entered the employ of the Studebaker Manufacturing Company, with which he had since been identified. In 1913 he was made master mechanic of the company, and was put in charge of extension work, building and equipping factories. He was often called upon as a consulting expert, because of his mechanical ability, for which he became very well known.

His wife, who was Miss Elsa Lichtenberg, and his four children survive him. He was a member of the University Club of Chicago, the Indiana Club, and the Psi Upsilon fraternity.

INDUSTRIAL REVIEW

Believing that our readers will be interested to know about the different bulletins published by various manufacturers descriptive of their apparatus, THE SIBLEY JOURNAL will be glad to review such bulletins as may arrive from time to time, and heartily requests that manufacturers send us such literature as they may have, regardless of whether they advertise with us or not. Among the bulletins which have come in during the last month, we find the following worthy of notice:

THE SPRAY ENGINEERING CO., 93 Federal St., Boston, Mass., specialists in the design, manufacture, and installation of systems for spraying water for cooling and aerating; air washers, and coolers, paint spraying machines and systems, have recently announced the "Spraco" Paint Gun described in their Bulletin No. 310. The "Spraco" Paint Gun is a practical hand tool for use in applying all kinds of liquid coatings. The complete equipment consists of the paint gun proper connected by a flexible hose to a portable unit composed of the material container, air dryer and strainer, pressure control attachment and pressure gauge. The paint gun will save a lot of time, give more uniform results and reach surfaces which could not be otherwise thoroughly covered by the use of a brush, and it is scarcely an exaggeration to say that it can be used to paint almost "anything under the sun."

THE L. S. STARRET CO., Athol, Mass., the well known manufacturers of fine machine and hand tools have announced the development of a new Hack Saw Machine. This machine is of particular interest since

it is the first machine ever put on the market by this famous tool company, whose name back of it is a sufficient guarantee of excellence. The four points about the machine which will commend it to practical shop men are as follows:

The first is the stroke adjustment which makes possible a stroke of practically the full length of the blade no matter what the size of the stock. This insures uniform wear of blades and faster cutting.

The second feature is the foot treadle for raising the saw frame. By it the operator's weight raises the saw instead of requiring him to exert his full strength in lifting. This feature also insures greater speed.

The third feature is an oil dash pot controlling the descent of the saw, allowing the machine to be started when the frame is up and preventing it from dropping and breaking the saw. It further eases the blade on to the work so that the teeth do not bite in so rapidly as to strip them or break the saw blade.

The fourth feature is the automatic locking device which prevents the saw dragging on the return stroke and holds the saw frame at any height when the machine is stopped for setting the work.

EMPLOYMENT NOTES

276. L. M. Rossi, Works Mgr., General Bakelite Co., Perth Amboy, N. J., wants Chem. Engineer and also E.E., having initiative and imagination, for research work. Prefer men of 3 or 4 years' experience.

277. W. H. Callan, Mgr., Chicago Pneumatic Tool Co., Franklin, Pa., wants M.E. for publicity.

278. Dr. Owen Copp, Supt. Pennsylvania Hospital, West Philadelphia, Pa., wants M.E. or E.E., with good business experience for executive assistance to Supt. to look after purchasing supplies; heat, light and power plants, mechanical and other departments and represent Superintendent as far as possible in such matters. Salary $2,000 to $3,000 according to experience and qualifications. "Good opportunity for development and advancement."

280. Mr. Jos. Tracy, Consulting Automobile Engineer, 1786 Broadway, New York City, wants a recent graduate for laboratory tests of gasoline engines, oils, brakes, etc. It is reported that there is a good future connected with the position.

282. Mr. L. W. Corbett, Chief Draftsman, Niagara Alkali Co., Niagara Falls, N. Y., wants draftsman for building construction, reinforced concrete, brick and steel work, but more especially for plant layouts and piping. Prefers man with one or two years' experience.

283. Mr. H. F. Lawrence, Test Engineer, American Engineering Co., Philadelphia, Pa., has openings in stoker operating department. Work consists of starting up new installations, instructing plant operators and conducting tests.

284. U. S. Civil Service Exam. No. 21 January 9, 1917, Leading Draftsman, Ordnance Dept., at Large, $2,400. Design of optical instrument gun sights, etc. Apply to Civil Service Commission, Washington, D. C., for Form 2118, stating title of exam.

285.* A coal mining company in Western Pa., wants recent graduate in Mining or Civil Engineering.

286.* A concern manufacturing refrigerating machinery wants recent graduate to assist in factory erection and plant installation. Chance for promotion to expert work. Only absolute abstainers from alcoholic drinks and men above average intelligence will be considered.

287.* A concern (located in Northern New York) which makes Vacuum Drying Apparatus, Vacuum Pumps, Condensers, etc., wants recent graduates. Men to spend say six months in shops to become acquainted with the apparatus. Then some time on tests and on superintending erection and operation—all with view to preparing for sales department, district manager, etc. "The future for the man taking this position is very promising."

*Address applications to this number, care of Sibley Employment Bureau for forwarding.

PERSONALS

Continued from page 112

E. W. Clarke, '05, is superintendent of the open hearth and mills of the Cambria Steel Company, at Johnstown, Pa.

Frank M. Sears, '05, is with the Norwood Engineering Company, Florence, Mass., manufacturers of mechanical filters and paper finishing machinery.

Rodney D. Day, '06, is assistant to the vice-president of the Pollak Steel Co., Cincinnati, Ohio. He was formerly with the Wm. Todd Co.

W. C. Stevens, '06, who has been district manager of the New York district of the Cutler-Hammer Mfg. Company, has just been appointed sales manager of the company, with headquarters in Milwaukee, Wis.

S. H. Woods, '06, is now connected with the International Motor Co., West End Ave., and 64th St., New York City.

W. H. Yates, '06, who is now in charge of the Duluth office of the Allis-Chalmers Company, is living at 1203 East Second St., Duluth, Minn.

E. T. Hobart, '08, has recently returned from Manchuria, where he has been employed by the Standard Oil Company.

T. D. Hodge, '08, is assistant superintendent of rolling mills at the Duluth plant of the United States Steel Corporation.

Ralph R. Lally, '08, in charge of the Kansas City district sales office of the National Tube Company, has his headquarters at 420 R. A. Long Building, Kansas City.

R. S. Baum, '09, is manager of the Hudson Sales Company. His address is 503 Richards St., Joliet, Ill.

(Continued on page 8 advertising section)

J. W. Cox, Jr., '09, superintendent of the Albany Felt Company, has been elected a member of the American Society of Mechanical Engineers.

Fred O. Ebeling, '09, has left the Gifford Wood Company, of Hudson, N. Y., to take charge of the De Pere, Wis., plant of Andrew W. Woodman & Company, Chicago, manufacturers of structural steel.

G. D. Gates, '09, has recently changed his address to 21 Glen Oak Ave., Dubuque, Iowa.

W. D. Wood, '09, and **J. P. Jones, '13,** are connected with the Lehigh Car, Wheel & Axle Works, of Catasauqua, Pa.

F. T. Brandt, '10, G. E. Evans, '11, H. B. Hull, '13, W. C. Suiter, '13, F. Downs, '14, and **D. F. Vanderlyn, '14,** are all in the employ of the York Mfg. Co., makers of refrigerating machinery, York, Pa.

W. W. Matchneer, '10, who is with the Buckeye Steel Castings Company, is now living in Columbus, Ohio.

T. R. Cox, Jr., '11, has changed his address from 3 Elk Street to 17 North Hawk Street, Albany, N. Y.

Julian P. Hickok, '11, is on the editorial staff of Lefax Magazine, the offices of which are located in the Shackleton Building, Philadelphia, Pa.

R. L. Leventry, '11, is an assistant superintendent at the open hearth plant of the Cambria Steel Company, at Johnstown, Pa.

G. W. Parkin, '11, until ordered to the border, was in the engineering department of the Lehigh Valley Railroad, 143 Liberty St., New York City. He is now serving with Company K, 7th New York Infantry, at McAllen, Texas.

W. B. Caldwell, '12, and Mrs. Caldwell, of Sharon, Pa., announce the birth of a second son, Walter Bruce Caldwell, Jr., on October 27, 1916.

J. F. Craig, '12, has left the Westinghouse Airbrake Company to go with F. W. Olin, Jr., '12, in the employ of the Western Powder Company, Alton, Ill.

F. W. Krebs, '12, who is with Donner Steel Company, Inc., of Buffalo, is, at the present time, in the Pittsburgh district, looking for material and equipment for a large extension which the company is making at the plant of the old New York State Steel Company in Buffalo.

A. T. Lockard, '12, is located in Chicago, as assistant to the Western Division Superintendent of the American Brake Shoe & Foundry Company.

Martin Schiff, '12, was married to Miss Edith M. Koontz, daughter of Dr. and Mrs. D. S. Koontz, of Mansfield, Ohio, on October 7, 1916. They have made their home at 245 Ocean Parkway, Brooklyn, N. Y.

G. W. Zink, '12, is works engineer of the Electric Cable Company, Bridgeport, Conn.

Morris Bradt, '13, has just accepted a position with the Castle KW. Company, Camden, N. J., as superintendent of mechanical and electrical departments.

A. C. Trego, '13, is assistant secretary of the Pennsylvania Mutual Liability Association, with office at 1709 Finance Building, Philadelphia.

Claude L. Turner, '13, is employed by The General Electric Company, at Schenectady. He is working in the marine department.

Joseph W. Ward, '13, is assistant sales manager in the recording thermometer department of the Taylor Instrument Companies, of Rochester, New York.

H. G. Weidenthal, '13, was married to Miss Louise Dorothy Strempel on November 27, 1916, at Cleveland, Ohio. Weidenthal is the engineer in charge of Heat Treatment and Research Departments of the Upson Nut Company of Cleveland. After January 1, 1916, Mr. and Mrs. Weidenthal will live in Detroit, Mich.

Mason Evans, Jr., '14, was married to Miss Mary Louise Taylor, daughter of Mr. and Mrs. W. E. Taylor of La Porte, Ind., on October 12. Mr. and Mrs. Evans are now living at 215 Lincoln Ave., Youngstown, Ohio.

Charles R. Hodges, Jr., '14, was married to Miss Frances C. Falconer, daughter of Mr. and Mrs. Sydnor M. Falconer, of Washington, D. C., on October 10. Hodges is with Wallace M. Reid & Co., casualty insurance, Union Bank Building, Pittsburg, Pa.

Donald H. Dew, '15, is doing some efficiency work for the Smith-Premier Typewriter Company at Syracuse.

C. P. Hubbard, '15, formerly with the C. H. Wheeler Mfg. Co., Philadelphia, is now in Japan, where he is engaged in power plant work for the American Trading Company. His headquarters are in Tokio.

R. B. Rodriguez, '15, expects to be sent in the near future to South America in some sales work for W. R Grace & Company, by whom he is employed as an engineer. He is living at the Central Y. M. C. A. in Brooklyn.

E. W. Bacon, '16, is working for the Lakeside Forge Company, Erie, Pa.

A. H. Bamman, '16, is with the Inspiration Consolidated Copper Co., Miami, Gila County, Arizona.

Alejandro R. Cota, '16, is instructing in the department of electrical engineering in Sibley this year. His address is 225 Bryant Ave., Ithaca.

C. W. Isbell, '16, is with the Isbell-Porter Company, Newark, N. J.

Felipe F. Vidal, '16, is chief engineer of the Valdes Railroad and Ferry Line between San Juan and Bayamon, Porto Rico. His address is Box 5, Bayamon, Porto Rico.

P. A. H. Weiss, '16, is in the engineering department of the Central Hudson Gas & Electric Company, Poughkeepsie. He lives at 40 Cannon St., Poughkeepsie, N. Y.

Chien Yang, '16, is studying at the Harvard graduate school of business administration, factory management being his major subject. His address is 362 Harvard Street, Cambridge, Mass.

The following 1916 men are in the employ of the Goodyear Tire & Rubber Company, of Akron, Ohio: **E. H. Baker,** specifications department; **H. H. Graef, Jr.,** and **C. J. Roese,** experimental department; **Ronald Hart** and **F. W. Pierce,** export department; **M. D. McMaster,** experimental department, Chicago branch; and **A. S. Ridgway,** planning department.

PERSONALS

Continued from page 116

John H. Raidabaugh, '05, has opened an office, in conjunction with F. G. Fahnestock, jr., an architect, in Rooms 401–402 Patriot Building, Harrisburg, Pa., for the practice of architectural and engineering work.

J. M. Fried, '07, and Mrs. Fried, of Vicksburg, Miss., announce the birth of a son, born on October 24, to whom they have given the name Saul.

B. Mason Hill, '07, is an electrical contractor in Petersburg, Va.

George H. Cunningham, '08, has resigned his position as superintendent of construction with the Anaconda Mining Company and accepted the position of chief engineer for the Electrolytic Zinc Company of Australia, with headquarters at Hobart, Tasmania.

Frederick O. Ebeling, '09, formerly engineer and draftsman for the Robins Conveying Belt Company, New York, has become associated with the Gifford-Wood Company, Hudson, N. Y., as sales engineer.

Hans C. Boos, '10, was married to Miss Ella Aralee Graybill, daughter of Major (C. S. A.) and Mrs. James Edward Graybill of New York, on June 21, 1916. Mr. and Mrs. Boos are living at 1905 Andrews Ave., New York. Boos is with The Curtainless Shower Company of New York and Chicago as stockholder and sales manager, he having discontinued his patent and engineering practice in March, 1916. The company manufactures the "Kenney Needle Shower."

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI FEBRUARY, 1917 No. 5

CONTENTS FOR FEBRUARY, 1917

Industry and the Engineer

When the late Frederick W. Taylor presented his monumental paper on "Shop Management" before the A. S. M. E. and made the claim for the first time, that there was a "science" back of the "art" of management his message was received with widely differing opinions. On the one hand it was hailed as a new gospel that would revolutionize shop management while on the other extreme it was condemned as visionary and impracticable. The truth in all probability lies somewhere between these extremes. We shall not perhaps realize all that Mr. Taylor hoped we could, but on the other hand, it has been made very clear that there are certain fixed principles that underlie management just as there are in any other activity where men must cooperate toward a given result.

Mr. Taylor's propaganda in fact was part of a general movement along these lines, a movement also that is of great interest to engineers. Even before his day other men had attacked the problem of the "business end" of manufacturing and managers and accountants had begun to enquire into the "science" of costs. And while a few years ago the literature of what may be called the science of business was exceedingly meager, today the literature of this subject is not only very voluminous but has passed the stage of generalities and is now becoming a literature of special subjects. Today in addition to the many general treatises on management we have books on cost finding, appraising, depreciation, marketing, advertising, salesmanship, corporation finance, insurance, real estate, purchasing, employment and many other items of business administration that formerly were matters largely of personal opinion and experience. Accounting in the meantime has risen from the simple old-fashioned bookkeeping to be a complex and important matter especially where large interests are concerned. Finally this movement is finding a larger expression in Schools of Commerce, so-called, attached to universities and colleges, private schools of the same character and also in highly developed extension and correspondence courses to aid those who cannot avail themselves of the organized schools. The latest and in some respects the most interesting recognition of this new industrial need is the issuance by the Federal Trade Commission of two pamphlets on cost finding, one for manufacturers and one for merchants.

The importance of these pamphlets does not lie in their content for they are very elementary as they

Continued on page 125

A STUDY OF THE THIN PLATE ORIFICE

By V. R. GAGE*

Synopsis

The salient points of the paper are briefly outlined as follows:

The first section of this paper deals with the measurement of the flow of water by means of Venturi meter and thin plate orifices.

Relation between Venturi meters and thin plate orifices.

Development of formula.

Featuring the great usefulness of the use of "logarithmic cross section paper" for certain types of mathematical formulae.

Presentation of the collection of data taken by students in the Mechanical Laboratory during the course of a term's work, using Venturi meter and three sizes of thin plate orifice.

Reasons for maximum and minimum capacity of these instruments.

Description of an easily constructed and applied measuring device.

Numerical values of coefficients are: 0.96 for Venturi within capacity limits, and 0.62 for each size of orifice for range covered.

The second section of this paper (which will appear in the next issue of the "Journal") deals with the measurement of the flow of air by means of thin plate orifices.

Development of formula.

Presentation of an easier method of handling the computations (See Mr. Colman's article, Trans. A. S. M. E.) and still easier approximations. Indicating the limits beyond which the approximations are not accurate. (See Prof. Upton's article in "Sibley Journal" for another method of attacking the same problem).

Mention is made of errors liable to creep in when using Pitot Tube. (See Mr. Moss' article presented at 1916 annual meeting of A. S. M. E.), and the use of impact tube and "static" holes to avoid causes of these errors.

Data was taken on cold days with high barometer, and with warm air and low barometer in order to secure widely different values of density.

Some peculiar coincidences are noted:

1. Relation of actual to indicated discharge has an exponent equal to twice the critical pressure ratio. 2. Relation of actual discharge to pressure difference has an exponent equal to one minus the critical pressure ratio, which also equals one-third of gamma. 3. The coefficient of the thin plate orifices is a variable, approaching the critical pressure ratio as an asymptote.

*Asst. Prof. of Experimental Engineering, Cornell University.

1. Measuring the Flow of Water

In measuring the quantity of fluid passing through a pipe the Venturi Meter is very satisfactory except for its size and cost. A similar device is a diaphragm or plate with a circular opening smaller than and concentric with the pipe, which may be slipped between the flanges of a joint. The objections to this form of Thin Plate Orifice are summed up in its apparent crudeness. The crudeness is more apparent than real.

The fundamental difference between the Venturi and the Thin Plate Orifice is that the former forces the fluid to assume the shape of the instrument, while the latter permits the fluid to form and follow the natural stream lines. As the stream contracts after passing through the orifice, the smallest area of the stream is not coincident with, nor equal to, the area of the orifice. In Figure 1 is shown a cross section of the Venturi. Figure 2 is a diagram cross section of the Thin Plate Orifice, the dotted lines representing, approximately, the boundaries of the moving stream.

Development of Formula

The best hypothesis on which to base the formula for these instruments is Bernoulli's theorem, which states that the total energy of a steadily flowing stream is constant, except for friction losses. If a gas is considered, it will be necessary to take into account the heat energy, but with a liquid this is not necessary as long as a change of state is not involved. The losses due to friction can be neglected in the hypothesis, and corrected for in combination with other factors, by using an experimentally determined coefficient to obtain the actual discharge.

For the present, the case of a liquid will be considered. The total energy of the stream is the sum of the Kinetic Energy or Velocity Head ($H_V = \frac{V^2}{2g}$) and the Potential Energy or Pressure Head (H). By restricting the area of the pipe the velocity is increased, hence the velocity head is also increased, and the pressure head is correspondingly reduced. But the sum of the two heads is unchanged. Let subscript 1 refer to the area of the pipe, subscript 2 to the restriction, and assuming the two to be in the same horizontal plane, then this equation is true.

$$H_1 + \frac{V_1^2}{2g} = H_2 + \frac{V_2^2}{2g} \qquad \text{[Equation 1]}$$

The velocity at the restriction is a function of the velocity in the pipe and the ratio of the areas. Let F denote rea, then

$$V_1 = \frac{F_2}{F_1} \times V_2$$

Knowing the dimensions at the two points, and observing the pressure heads at the two points (in practice

the difference of the pressure heads at the two points is observed, and hereafter this will be called the pressure difference) the only unknown in Equation 1 is velocity

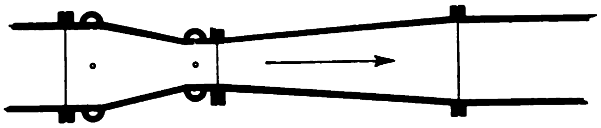


FIGURE 1.
Diagram Cross-section through a Venturi Meter.

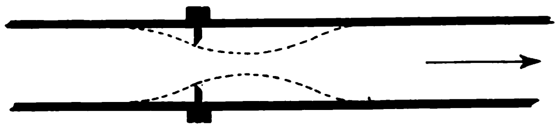


FIGURE 2.
Diagrammatic Representation of the Cross-section of a Thin Plate Orifice in a Pipe, Stream Lines indicated by Dots.

at one point, which can be solved for. Thus is obtained the value of the velocity at the restriction, and this multiplied by the area at this point gives the quantity flowing per unit time. Expressed as an equation this is

$$Q = F_2\sqrt{\frac{2g}{1-\left(\frac{F_2}{F_1}\right)^2}}\;\sqrt{H_1-H} \qquad \text{[Equation 2]}$$

which may be simplified, for any one combination of areas, by putting it in the form

$$Q = M\,(H_1 - H_2)^{1/2}$$

in which M is a constant $= F_2\sqrt{\dfrac{2g}{1-\left(\frac{F_2}{F_1}\right)^2}}$

Equation 2 is of the form $Q = m\,h^n$ which is the equation of a parabola. By taking the logarithm of each term this becomes

$$\log Q = \log m + n \log h$$

which is the equation of a straight line.

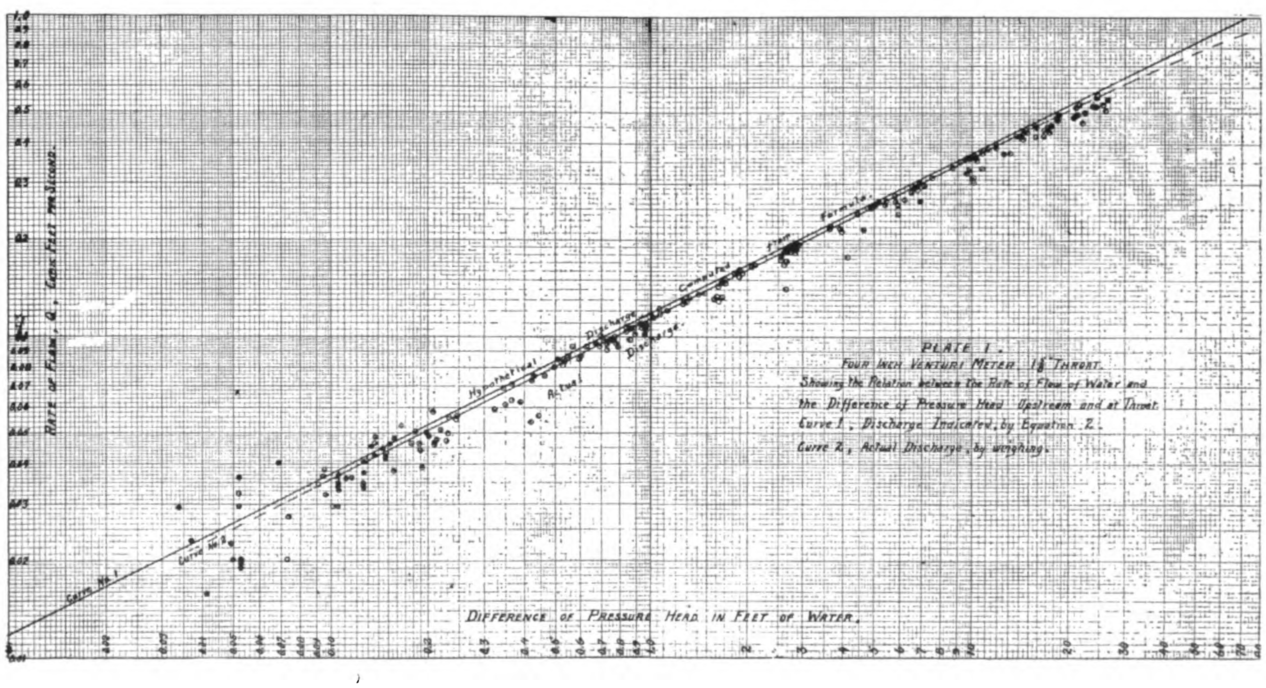
It is easier to use cross section paper on which the distances are proportional to the logarithms of numbers than it is to use ordinary uniform scale cross section paper and then to look up the logarithm of each number, and the result is the same. The straight line can be drawn through one point when the slope (n) is known. The parabola needs many points for accuracy. Plate 1 Curve 1 shows equation 2 for a four inch diameter upstream and a one and five-eighths inch diameter throat section. The scaling is such that the distances are proportional to the logarithms of the quantity discharged for unit time vertically, and of the pressure difference horizontally.

Description of Apparatus and Tests

In the mechanical laboratories of Sibley College at Cornell University there is given an experiment on the Measurement of Hydraulic Flow. For this, the water is supplied by a motor driven centrifugal pump, passing through a pressure regulating tank, a Venturi meter, a Thin Plate Orifice in the pipe, a common type of water meter which can be shunted for quantities in excess of its capacity, a Pitot Tube, a header for various forms of nozzles, three weir tanks with three distinct types of weirs, and a very large capacity tank hung from special scales into which the water may be diverted and the true quantity rate determined for a period of about four minutes on the average.

The data taken by the students in the course of a term's work has been tabulated and worked up, and a few sets rejected because of erroneous data. About forty separate sets of data are represented. Only the portions relating to the one Venturi Meter and the three different sizes of Thin Plate Orifice are plotted here.

The Venturi Meter was of standard design and as regularly furnished. It was for a four inch pipe, and had a throat diameter of one and five-eighths inch.



The capacity, as rated by the builders, is for the range of from 0.04 to 0.528 cubic feet per second.

The Thin Plate Orifice was specially constructed of a cast iron ring about one inch thick to fit between the flanges of a flanged joint in the four inch pipe. On the inside of the ring was a projection to which brass plates could be screwed. The openings in the plates were sharp edged up stream, and beveled down stream, and the sizes used were one and one-half inch, two inch, and two and one-half inch diameters. The openings or holes for obtaining the pressure difference across the orifice were for one-quarter inch pipe connections, and were drilled at the top of the ring and as close to the brass plate as possible. Figure 3 shows a cross section through the joint and orifice and also a face view of the orifice in the pipe.

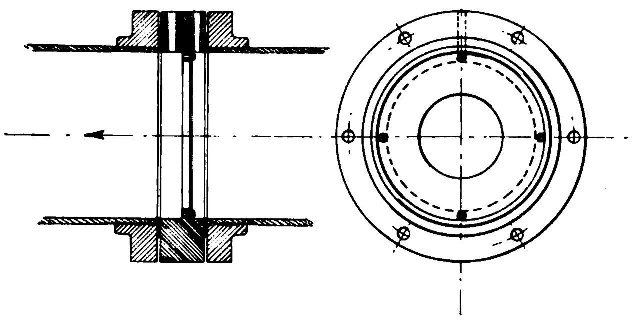


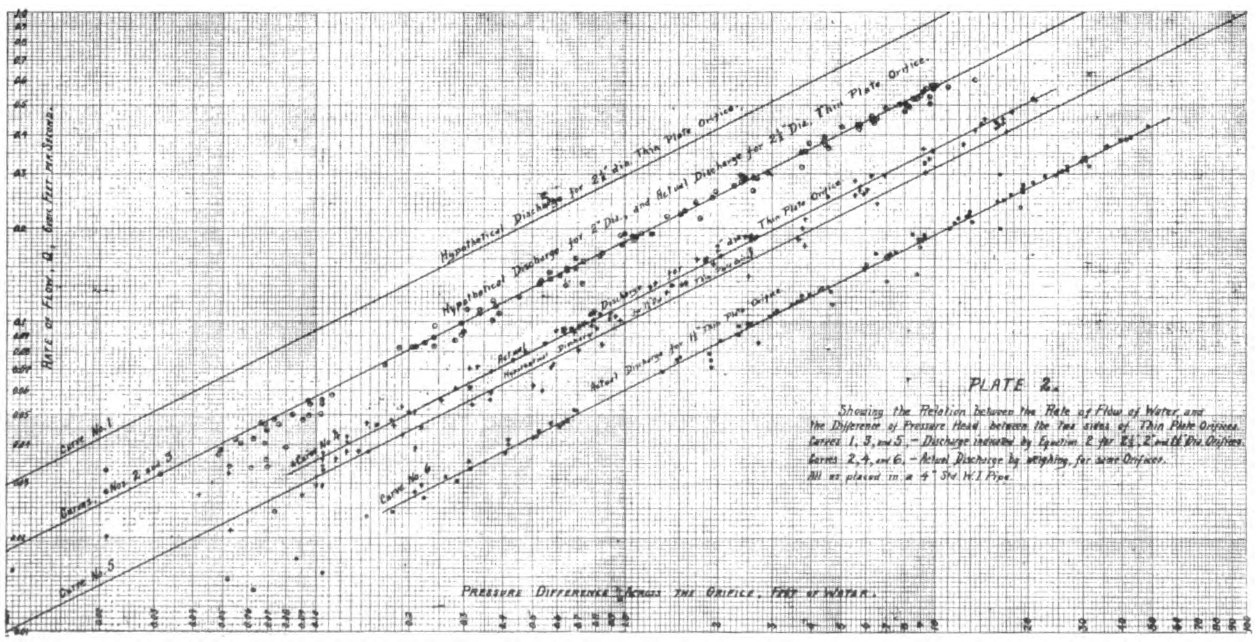
FIGURE 3.
Sketch of Thin Plate Orifice for Use in Flanged Pipe Joint Not to scale. Arrow shows direction of flow. Cocks to be placed on manometer pipes to let out air.

The manometers were specially constructed with two vertical glass tubes, sliding scales, to read the pressure difference. The connections to the instruments were made at the top, and care was taken that no air was trapped in the connections. Mercury was used, with water over it. It will be noticed that the points from data with small quantities flowing scatter. That is because these manometers are not sensitive enough for small pressure differences. At present, air and water manometers can be cut in for the small pressure differences, but no data from the air and water manometers is used here.

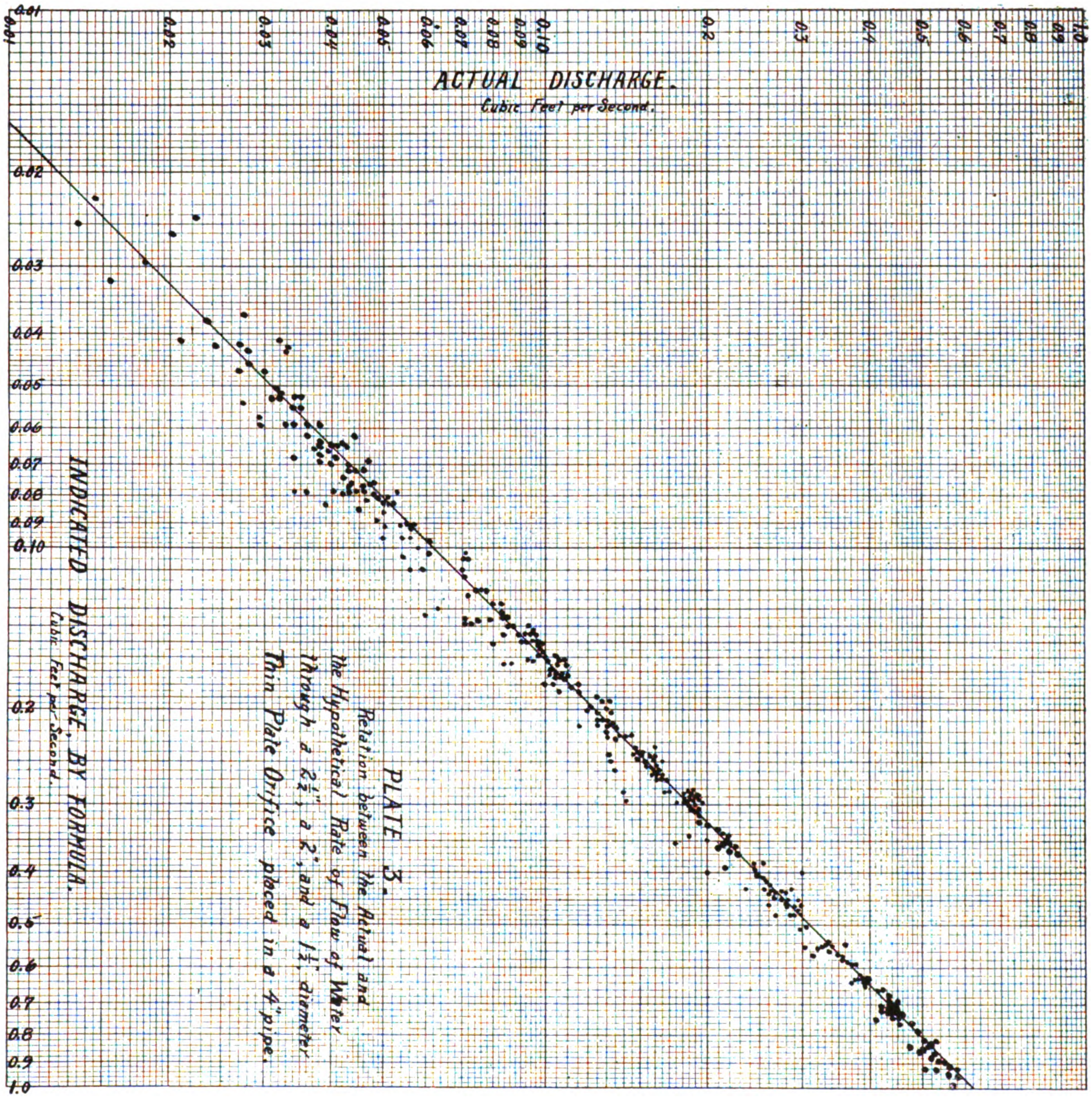
On detailed plotting it was noticed that some days would plot consistently lower than others, on psychological study it was found to agree with the temperament of the man signalling time, and the man diverting the water into the weighing tank. Some men can not make their muscles respond as quickly as others. This is not shown here, but explains the effect of a broad band of points.

Plate 1 has quantity as ordinates and pressure differences as abscissa. Curve 1 is the hypothetical discharge for the Venturi dimensions according to Formula or Equation 2. Curve 2 represents the actual discharge for any given pressure difference, as obtained from the experimental data. If this curve was to be used in practice it would be better to use for abscissa the same units of pressure difference which are read from the manometer. The scattering of the points observed at small flows has been explained. For the greater flows, near the upper limit of capacity as set by the builders, the actual discharge curve appears to commence to drop off because the design of the Venturi is such that the stream does not completely fill the throat, and the friction also increases. For the most of the range of use, however, the slope of the actual curve is the same as that of the hypothetical, thus indicating that the coefficient is a constant for the most part of the range of capacity covered. In detail, with the manometers used the smallest rate of flow for accurate work is 0.07 cubic feet per second, approximately. The slope of the hypothetical and actual curves is the same, that is one-half, up to about 0.5 cubic feet per second. And between these limits the hypothetical discharge, for any given pressure difference, when multiplied by 0.96 gives the actual discharge, in other words, the coefficient is 0.96.

As already stated, three sizes of orifice were used. Plate 2 is devoted to the results of the Thin Plate



Orifice, the logarithmic scale cross sectioning is used, and the abscissa and ordinates represent respectively pressure difference and rate of flow as in Plate 1. Curves 1, 3, and 5 represent the relation between hypothetical discharge and pressure difference, using equation 2. Curves 2, 4, and 6 represent the relation between actual discharge and pressure difference, as obtained from experimental data. As with the Venturi, when the rate of flow is insufficient to cause considerable pressure difference, the manometers were not should be noted, that is, that the system was operated up to practically maximum capacity each day, and that the smaller orifices reduced the capacity of the system. See the maximum rates of discharge on Plate 2. The centrifugal pump is, practically, a constant head device, so that the pressure was at all times nearly constant on the upstream side of the orifice. For further study of these orifices it would be desirable to have some means of increasing this pressure.



sensitive enough to give satisfactory indications. The actual curves have a slope of one-half and apparently do not tend to fall away at the greater rates of discharge, although it is to be expected that they will drop off, curving away from the slope of one-half, when the flow becomes too great. The coefficient of each is nearly 0.62.

It seems peculiar that all of the orifices gave practically the same coefficient, and also that the coefficient remained constant for all rates of flow. One factor

In order to check the conclusions mentioned at the first of the last paragraph, Plate 3 was plotted with actual discharge as ordinates and hypothetical discharge as abscissa, using all the data from each orifice. (As the points indicate $\log y = \log m + 1 \log x$ or $y = mx$ ordinary equal spaced cross sections paper could have been used just as well.) The data thus plotted shows the relation between the actual and indicated discharge is the same for all three sizes of orifice, and that the coefficient is a constant for all rates of flow, and has

a value slightly less than 0.62. It is the belief of the writer that this curve will drop off as the discharge is increased, and that the reason it does not do so is that the rate of flow was not great enough in these experiments.

Explanation of Value of Orifice Coefficients

The reasons for the low numerical value of the coefficients of the sharp edged thin plate orifice are: first, the contraction of the stream; second, the friction (eddy current) losses; third, the measurement of the pressure head.

The contraction of the jet. Numerous experiments have shown this to vary with the head, and with the relative areas of the orifice and channel of approach, and with the sharpness of the edge of the orifice. Mathematically, it can only be computed for certain assumptions which are incomplete and not always correct, but the value thus computed is somewhere around 0.6.

The friction losses are caused mainly by the swirling motion of the water for non-viscous flow, and are shown by the loss of head and perhaps by the "throttling" action of the smaller orifices already referred to, although the limiting velocity for a given pressure, and the inability of the centrifugal pump to increase the pressure, may be elements of this "throttling."

The measurement of pressure head of moving fluids is always hard to accomplish. On the upstream side of the orifice there will be a "banking up," and the pressure head will be greater at the wall of the pipe close to the orifice. On the downstream side the direction of the eddies at the pressure opening may affect the reading, making pressure either too great or too small.

In connection with the above statements a warning should be given, that unless a duplicate of this orifice is used, the coefficients may not be the same.

NOTE—Experiments recently made public verify the above statements. See *Journal A. S. M. E.*, September, 1916. Professor Judd's paper on Experiments on Water Flow Through Pipe Orifices, and *Journal of A. S. M. E.*, December, 1916, p. 1001.

"TONNAGE" FROM "KNOW YOUR OWN SHIP"

By WISER BROWN

Importance to Ship Owners

Ships' dues such as pilotage, dock, river, etc., are paid on the register tonnage. Tonnage is, therefore, of great importance to the ship owner, from an economical point of view. Nevertheless, considerable misunderstanding is prevalent as to what tonnage really is. The misunderstanding comes from confusing displacement tonnage with register tonnage.

Displacement tonnage is the number of tons of water the ship displaces and is equal to the buoyant forces necessary to float the ship.

Register tonnage does not, as some would imagine, give any idea of the size of a vessel, for, an ordinarily proportioned vessel, 250 feet long, may have a register tonnage of 700, and another of identical proportions may have a register tonnage of only 300, and yet both vessels may have equal displacements. Thus we gather that register tonnage gives no criterion of comparison between one vessel and another as to their dimensions, displacements, or dead weights.

A glance at a board of trade certificate of survey for any vessel, or a register of shipping, shows three distinct tonnages, viz.: Under deck, gross, and register. One ton of under deck, or gross tonnage, is equal to 100 cubic feet of capacity, so that these tonnages may convey some idea of the entire internal capacity of a vessel. Register tonnage, however, is a number having no dependence on the internal capacity as a whole, as already stated, but is modified by the arrangement of the vessel, as affected by the space occupied by the propelling machinery and the crew, as well as other deductions allowed by the American shipping act of 1894.

Under deck tonnage is the total tonnage up to the tonnage deck, and is the first part of the vessel measured for tonnage.

Under deck tonnage is measured as follows:

If the vessel is constructed with ordinary floors, the depth at any part of the length of the vessel to the tonnage deck is measured to the top of the floors, afterwards deducting the average thickness of the ceiling, which is generally about two and one-half inches, to one-third the camber of the beam, down at the center of the beam.

Should the vessel be built with a double bottom, the depth is taken from the height previously described down to the plating forming the top of the double bottom where no ceiling is laid; or, where there is ceiling, the average thickness is deducted from this depth—no allowance whatever being allowed for grounds fitted between the tank top plating and the ceiling.

Where a vessel is constructed with ordinary floors at one part of her length, and double bottom at another, the tonnage in the range of each part is computed separately, and depths are measured, in each case, as previously described for vessels with ordinary bottoms and double bottoms.

The tonnage measurements for breadth are taken from the inside of the sparring in the hold. Sometimes, instead of wood sparring, half round iron is fitted to the reverse frames, especially in colliers. In this case the breadths are taken from half round iron, side to side. Where neither wood nor half round iron is used the breadths are taken to the reverse frames, or, to the inside of the framing.

The length for under deck tonnage is measured from the points at the extreme ends of the vessel where the inside lines of the sparring unite, or in the case where

no sparring of any sort is used, to the points, where lines forming the inside of the framing unite.

The Board of Trade Surveyor then measures the inside of the vessel to the positions indicated, and by Simpson's rules the cubic capacity in feet is found. If anything, this method of finding the cubic capacity by these rules, gives the capacity rather under the actual, so the difference is slightly in favor of the ship owner. In the case of the raised quarter deck type the tonnage deck is the main deck, and where the main deck stops, and the raised deck begins the line of the main deck is taken as the tonnage deck, and the capacity of the raised quarter deck is computed separately.

Gross Tonnage

Gross tonnage comprises the under deck tonnage, together with all enclosed erections in the form of poops, forecastles, spar decks, awning decks, raised quarter decks, deck houses, engines and boiler casings, etc. The chief exception to this rule is that the crew's galley, crew's w.c.'s, and companions are usually omitted in the calculations for tonnage.

By enclosed erections is meant spaces enclosed in on all sides; for example, poops with closed fronts of wood or iron, bridges with closed ends, and forecastles with closed ends. Open ended poops, bridges, forecastles, or deck shelter, used only for the protection of passengers from the sea and weather, are not included in the gross tonnage. Should, however, any houses or store rooms of any kind be constructed beneath an open ended shelter they are reckoned in the gross tonnage.

Register Tonnage

Register tonnage is obtained from the gross tonnage after certain allowed deductions have been made, and as the various dues and charges are levied on this tonnage, the nature of these deductions will form the subject of our next consideration. First of all it must be understood that no deduction for any space whatever is made, unless it be first included in the gross tonnage. Deductions are allowed for the following:

1. Crew space.
2. Master's accommodations.
3. Engineer's and Officers' accommodations.
4. W. C.'s.
5. Sail room.
6. Boatswain's store.
7. Wheel room, etc.
8. Donkey boiler.
9. Deck shelters (with limitations).
10. Propelling deduction.

Finally, students should not attempt to specialize but should get a broad, general training in fundamental principles, together with enough of their applications to fix them thoroughly. On the other hand, the mistake should not be made of confusing breadth with superficiality. A man can be broad and at the same time thorough.—McKibben.

EDITORIAL

Continued from page 119

should be. But it is significant that the Federal Trade Commission should recognize the fact that as a nation we are lamentably lacking in the elementary knowledge that underlies this fundamental subject. We are as meagerly informed as a nation on many other aspects of business both in manufacturing and in the distribution of our products.

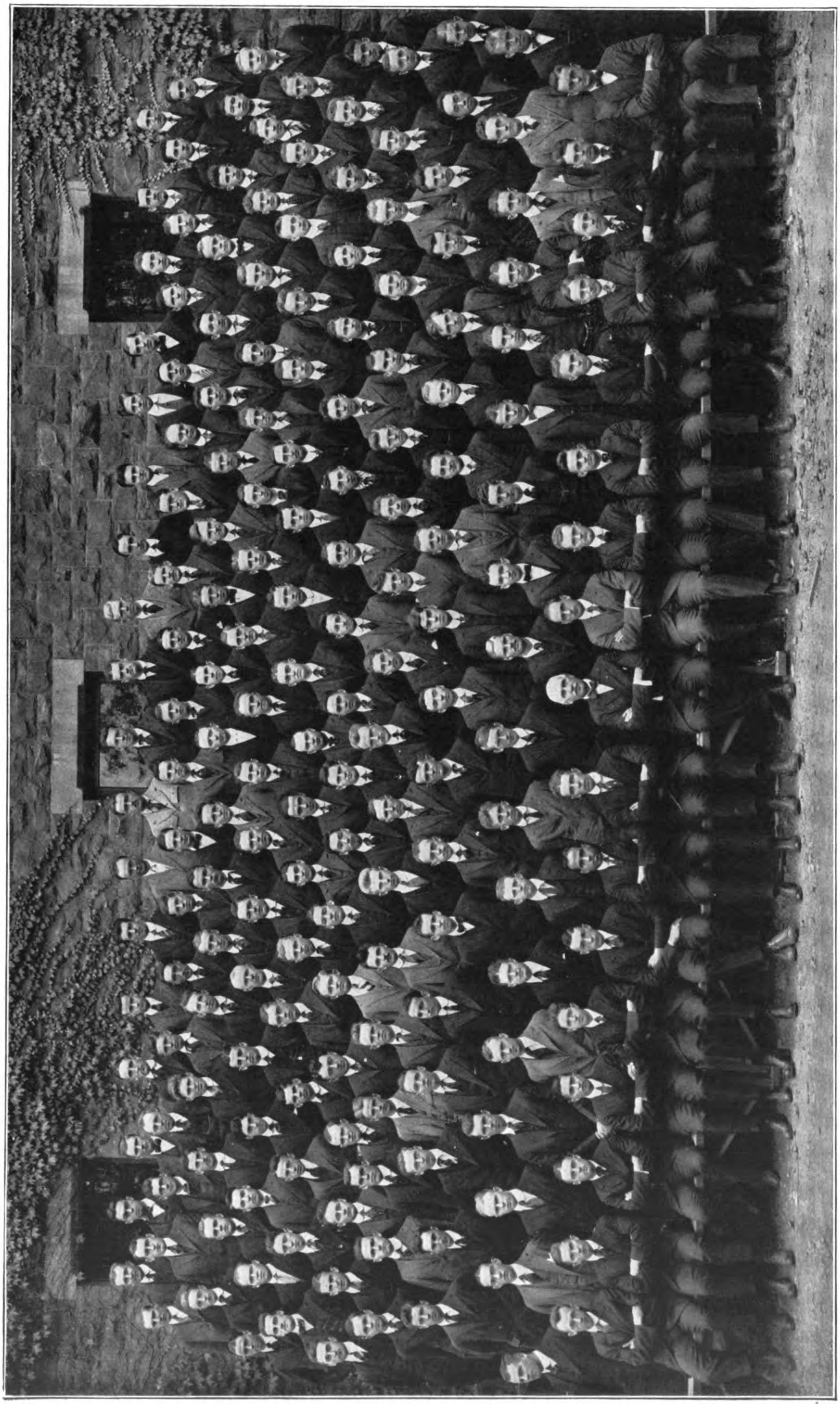
These matters are of particular importance to the engineer using the term in its broadest significance. Whether he wills it or not, the engineer is being rapidly drawn into the executive and administrative side of industry. It is not enough that he can design and build good machines, he must be prepared to discuss the economics of organization, plant location, plant equipment and the finance of manufacturing and even of marketing. It is not sufficient that he can survey a right of way, he must also be prepared to compute its economic value and disadvantages. It is not contended that the engineer's greatest opportunity lies in these fields. Good men are needed in all fields. There is still a large place for the man with the inventive mind and for the man who is a good designer and builder; but these new fields certainly do open up new opportunities to the engineer who will equip himself with a knowledge of the economics of industry.

Dexter S. Kimball.

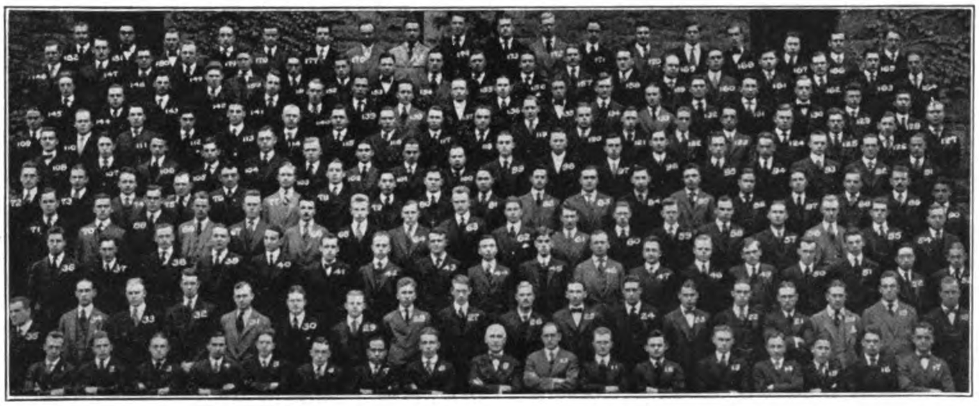
The character of the technical man's language is important in his social and business intercourse; in his business and professional correspondence; in the promulgation of orders, rules and regulations for the guidance of those under his direction; in the preparation of specifications, contracts, and reports; in writing and delivering addressed and technical papers; and, in writing technical books for the advancement of his profession.—Harrington.

In connection with the work in this and other departments the effort should be made to bring the students to a keener appreciation of the value of a working command of English. They should be shown that it is not enough that they possess the knowledge, but they must have the ability to convey to others, and especially to their clients in language concise and free from ambiguity, the results of their professional or administrative work.

Specifications and reports may not concern you soon, but at the very outset of your professional career you will surely have occasion to write letters. A sloppy, slovenly, confusing, ambiguous letter produces the same effect as a display of dirty hands, unkept attire, and general personal untidiness. Your professors have told you this in substance, and have corrected your English; and you have considered their opinions to be due merely to their academic idiosyncrasies; but let me assure you that they have overlooked your lapses far more readily than will your business critics. —Howard.



SIBLEY SENIORS—CLASS 1917



KEY TO THE SENIOR CLASS PICTURE

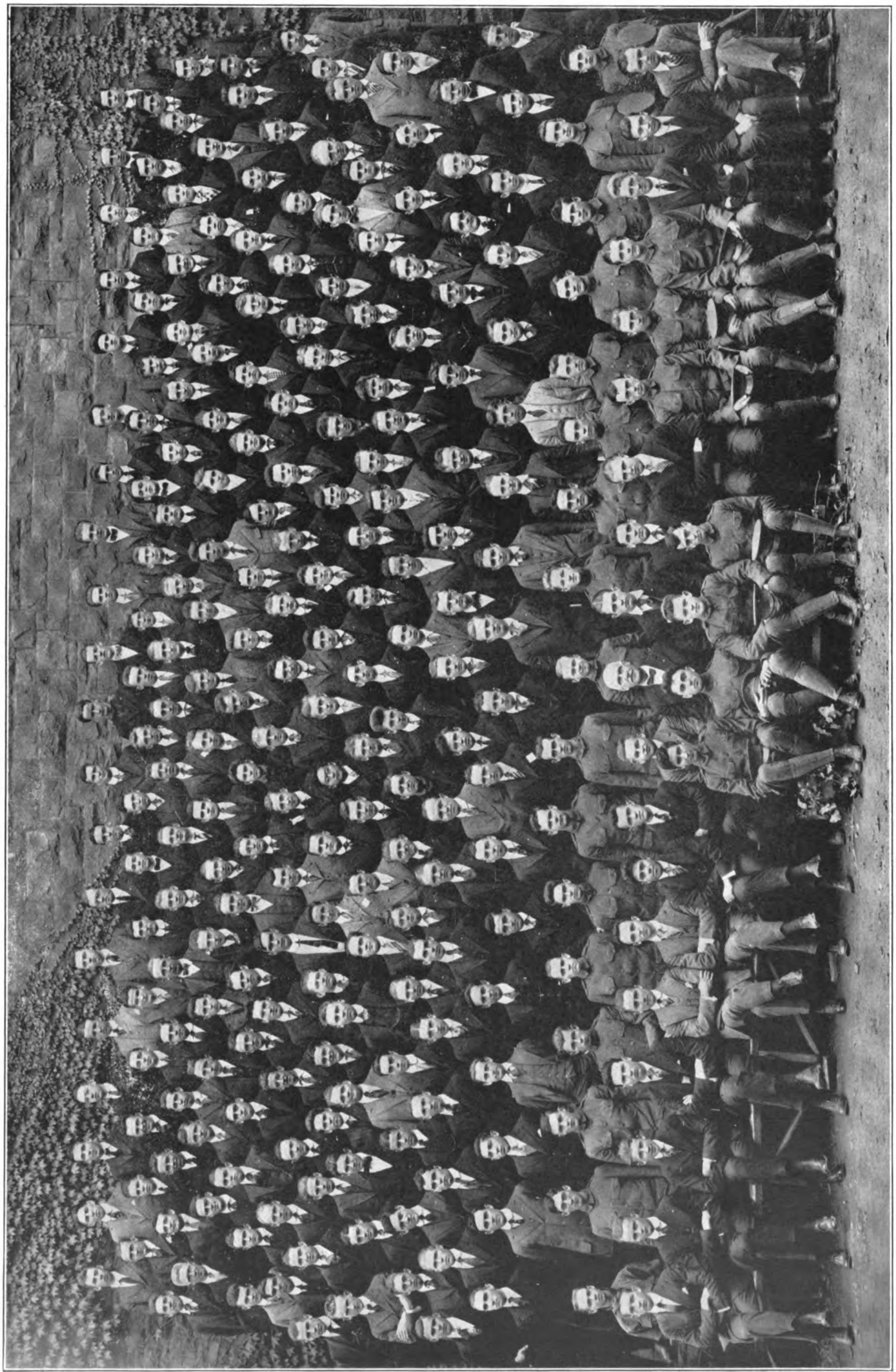
Sibley College, Cornell University

Alphabetical List.

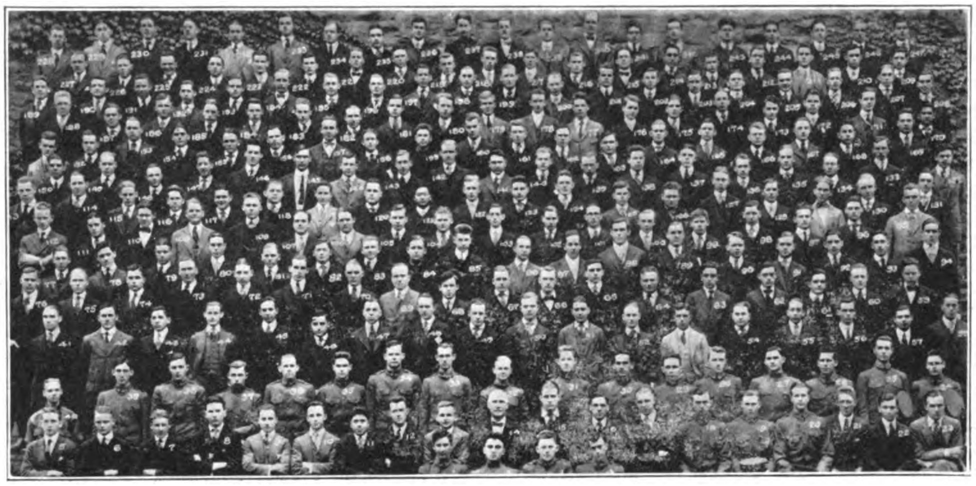
24 Acker, E. R.
54 Allbright, J. G.
106 Ayau, M. S., Jr.
174 Badenhausen, C. W.
6 Bahney, R. H.
176 Baker, W.
179 Baldwin, C. G., Jr.
112 Bancel, A. F.
43 Banks, D. K.
91 Barber, R. S.
12 Barr, S. M.
40 Bartolicius, L. W.
15 Bellis, W. C.
42 Bick, H N.
104 Bliss, W. C.
33 Bockius, G. H.
120 Boggis, H. P.
86 Bollman, G. H.
62 Bomeisler, C. M.
7 Bose, S. N.
98 Brenton, W
8 Brewer, I.
56 Bright, M. C.
19 Brinckerhoff, J. E.
3 Brown, S. T.
18 Brown, W.
67 Burpee, C.
65 Buys, I.
119 Calder, W., Jr.,
99 Caldwell, H. W.
44 Caldwell, J. C.
92 Callan, J.
58 Cassidy, G. E.
53 Chandler, D. H., Jr.
37 Chapin, S. L.
71 Chapman, R. H.
82 Cohen, E. M.
143 Coleman, G. K.
182 Collyer, J. L.
46 Compton, R O.
133 Cooke, E. B.
167 Corcoran, E. S.
1 Corliss, L. F.
31 Coulter, W. A.
17 Coursen, R. C.
57 Crandall, A. B.
100 Damsky, C. D.
131 Davis, W. G.
60 DeGroat, W. F.
121 Derham, J. J., Jr.
158 Diederichs, H. N.
173 Dutcher, F. H.
81 Earnshaw, R.
126 Ebaugh, L. A.
163 Eckley, W.
146 Elmendorf, H. M.
102 Emich, H. C.
156 Erwin, G. L., Jr.
84 Estabrook, H. C.
76 Etshokin, L.
142 Galbreath, L. J.
123 Garbarino, J. A.
137 Gates, J. G.
94 Gilcher, R. J.
124 Golden, N. G.
153 Goodman, W. E.
88 Greuter, R. E.
178 Hagen, A. M.
154 Hambleton, R. L.
113 Hamm, O. H.
45 Hammond, F. M.
30 Hanighen, J. J., Jr.
144 Hatch, A. S.
13 Haydock, J.
69 Hendee, R. W.
83 Homer, E, C.
107 Houck, H. F.
11 Hough, C. C.
29 Houston, C. M.
147 Howard, D. J.
36 Huck, L. C.
161 Huntington, M. B.
2 Jagger, E. P.
55 James, W. R.
63 Johnston, W. D.
132 Jones, R. C.
75 Jones, T. R.
149 Kalbfus, J. B.
74 Kammerer, W. C.
87 Keefe, R. E.
32 King, W. G.
118 Landmesser, W. R.
171 Lautz, C. F.
23 Lautz, T. V. V.
122 Law, S. O.
155 Leighton, K.
89 Leonard, G. R.
109 Lopez, J. H.
21 Luce, R. F.
108 McChesney. J. D.
170 McCormick, W. S.
117 McCurtain, E. L.
95 Malone, E. L.
35 Marston, O. R.
25 Martin, J. W. H.
59 Matthews, J. E.
28 Meissner, H. G.
152 Merrick, J. F.
151 Meyer, G. C.
127 Meyer, R. O.
16 Molony, H. M.
96 Morris, J. S.
64 Morris, R. L.
181 Mueller, L. W.
159 O'Brien, D. H.
145 Ogren, C. F
130 Othus, J. C.
162 Palen, F. G.
125 Parkhill, M. S.
93 Pefley. H.
129 Pennington, V. P
101 Pierson, E. L.
72 Plunkett, C. E.
41 Polson, A. V.
22 Porter, H. W.
97 Ramage, R. W
68 Ramsey, C H.
77 Randolph, F. H.
26 Read, E. C.
150 Reynolds, R. K.
27 Richardson, L. L.
105 Robertson, W. W., Jr.
141 Ropes, J. M.
177 Roth, W. E.
4 Ruiz, J. J.
51 Salinger, A. Jr.
47 Schartel, L. T.
66 Schively, Y. R.
175 Schmidt, C. W.
138 Schneider, H. C.
70 Searles, H. N.
38 Seibert, E. W.
136 Shepard, C. D.
114 Shull, C. O.
9 Smith, Dean A. W.
80 Smith, B. A.
20 Smith, C. D.
135 Smith, E. L.
48 Smith, H. C.
134 Spreckels, C. H., Jr.
180 Sprong, E. A., Jr.
10 Stahl, G. D.
168 Stanley, C.
50 Sternberger, R. O.
157 Strauch, A. T. Jr.
160 Strong, H. M.
34 Tallman, F. G., Jr.
115 Taylor, R. C.
111 Timmerman, A. P.
52 Ting, Q.
148 Titchener, W. E.
165 Tomlines, T. F. I.
39 Tree, R. T.
79 Tsang, K. C.
90 Tuttle, W. S.
166 Valade, E. A.
172 Vickers, J. H.
14 Vollrath, J. C.
116 Watkins. E. H.
49 Watson, J. L.
85 Watt, R. M.
78 Wheeler, W. J.
140 White, DeG.
110 White R. M.
61 Williams, C. F.
103 Williams, P. A.
73 Wilson, S. C.
5 Woodward, A. C.
169 Worn, G. A.
139 Wright, A. M.
164 Wright, F. W
128 Yamshita, S.

Numerical List.

1 Corliss, L. F
2 Jaggard, E. P.
3 Brown, S. T.
4 Ruiz, J. J.
5 Woodward, A. C.
6 Bahney, R. H.
7 Bose, S. N.
8 Brewer, I.
9 Dean A. W. Smith
10 Stahl, G. D.
11 Hough, C. C.
12 Barr, S. M.
13 Haydock, J.
14 Vollrath, J. C.
13 Bellis, W. C.
16 Molony, H. M.
17 Coursen, R. C.
18 Brown, W.
19 Brinkerhoff, J. E.
20 Smith, C. D.
21 Luce, R. F
22 Porter, H. W.
23 Lautz, T. V. V.
24 Acker, E. R.
25 Martin, J. W. H.
26 Read, E. C.
27 Richardson, L. L.
28 Meissner, H. G.
29 Houston, C. M.
30 Hanighen, J. J., Jr.
31 Coulter, W. A.
32 King, W. G.
33 Bockius, G. H.
34 Tallman, F. G., Jr.
35 Marston, O. R.
36 Huck, L. C.
37 Chapin, S. L.
38 Seibert, E. W.
39 Tree, R. T.
40 Bartolicius, L. W.
41 Polson, A. V.
42 Bick, H. N.
43 Banks, D. K.
44 Caldwell, J. C.
45 Hammond, F. M.
46 Compton, R. O.
47 Schartel, L. T.
48 Smith, H. C.
49 Watson, J. L.
50 Sternberger, R. O.
51 Salinger, A. Jr.
52 Ting, Q.
53 Chandler, D. H.. Jr.
54 Allbright, J. G.
55 James, W. R.
56 Bright, M. C.
57 Crandall, A. B.
58 Cassidy, G. E.
59 Matthews, J. E.
60 DeGroat, W. F.
61 Williams, C. F.
62 Bomeisler, C. M.
63 Johnston, W. D.
64 Morris, R L.
65 Buys, I.
66 Schively, Y. R.
67 Burpee, C.
68 Ramsey, C. H.
69 Hendee, R. W.
70 Searles, H. N.
71 Chapman, R. H.
72 Plunkett, C. E.
73 Wilson, S. C.
74 Kammerer, W. C.
75 Jones, T R.
76 Etshokin, L.
77 Randolph, F. H.
78 Wheeler, W. J.
79 Tsang, K. C.
80 Smith, B. A.
81 Earnshaw, R.
82 Cohen, E. M.
83 Homer, E. C.
84 Estabrook, H. C.
85 Watt, R. M.
86 Bollman, G. H.
87 Keefe, R. E.
88 Greuter, R. E.
89 Leonard, G. R.
90 Tuttle, W. S.
91 Barber, R. S.
92 Callan, J.
93 Pefley, H.
94 Gilcher, R. J.
95 Malone, E. L.
96 Morris, J. S.
97 Ramage, R. W.
98 Brenton, W.
99 Caldwell, H. W.
100 Damsky, C. D.
101 Pierson, E. L.
102 Emich, H. C.
103 Williams, P. A.
104 Bliss, W. C.
105 Robertson, W. W., Jr.
106 Ayau, M. S. Jr.
107 Houck, H. F.
108 McChesney, J. D.
109 Lopez, J. H.
110 White, R. M.
111 Timmerman, A. P.
112 Bancel, A. F.
113 Hamm, O. H.
114 Shull, C. O.
115 Taylor, R. C.
116 Watkins, E. H.
117 McCurtain, E. L.
118 Landmesser, W. R.
119 Calder, W., Jr.
120 Boggis, H. P
121 Derham, J. J., Jr.
122 Law, S. O.
123 Garbarino, J. A
124 Golden, N. G.
125 Parkhill, M. S.
126 Ebaugh, L. A.
127 Meyer, R. O.
128 Yamashita, S.
129 Pennington, V. P.
130 Othus, J. C.
131 Davis, W. G
132 Jones, R. C.
133 Cooke, E B.
134 Spreckels, C. H., Jr.
135 Smith, E. L.
136 Shepard, C. D.
137 Gates, J G.
138 Schneider, H. C.
139 Wright, A. M.
140 White, DeG.
141 Ropes, J. M.
142 Galbreath, L. J.
143 Coleman, G. K.
144 Hatch, A. S.
145 Ogren, C. F.
146 Elmendorf, H. M.
147 Howard, D. J.
148 Titchener, W. E.
149 Kalbfus, J. B.
150 Reynolds, R. K.
151 Meyer, G. C.
152 Merrick, J. F.
153 Goodman, W. E.
154 Hambleton, R. L.
155 Leighton, K.
156 Erwin, G. L.
157 Strauch, A. T., Jr.
158 Diederichs, H. N.
159 O'Brien, D H.
160 Strong, H M.
161 Huntington, M. B.
162 Palen, F. G.
163 Eckley, W.
164 Wright. F. W.
165 Tomlines, T. F. I.
166 Valade, E A.
167 Corcoran, E. S.
168 Stanley, C.
169 Worn, G. A.
170 McCormick, W S.
171 Lautz, C. F
172 Vickers, J H.
173 Dutcher, F. H.
174 Badenhausen, C. W.
175 Schmidt, C W.
176 Baker, W
177 Roth, W E
178 Hagen, A. M.
179 Baldwin, C. G., Jr.
180 Sprong, E. A., Jr
181 Mueller, L. W
182 Collyer, J L.



SIBLEY FRESHMEN—CLASS 1920



FRESHMEN CLASS OF SIBLEY COLLEGE, CORNELL UNIVERSITY, 1920

84 Acker, G. H.
55 Aikins, J. R.
99 Alcus, F. L.
202 Aldridge, A. M.
197 Allen, E. W.
228 Allen, H.
32 Anderson, C. A.
216 Armstrong, G. E.
18 Armstrong, J. B.
222 Arter, C. L.
221 Athans, G. E.
149 Atwood, J. C.
180 Baer, W. A.
163 Baer, W. D.
200 Ball, T. M.
116 Barkdull, R. E.
206 Beeler, C. F.
62 Bell, J. S.
158 Beveridge, J. M.
193 Bixler, D. F.
211 Bleecker, W. G.
232 Pollinger, R. L.
123 Driggs, H. O.
95 Brogan, M. P.
56 Brown, W. B.
186 Buehler, L. Jr.
225 Burk, R. M.
139 Burke, J. H.
68 Burt, R. C.
108 Buschman, R. P.
83 Byrd, R. H.
85 Carney, C.
166 Carr, H. R.
11 Carrino, C. N.
162 Carson, J. R.
76 Cary, E. B.
188 Christie, L. D.
6 Clair, H. C. Jr.
241 Clarke, W. H.
115 Clay, G. W. Jr.
29 Colson, A. E.
207 deConingh, P. C.
214 Covert, K. C.
124 Craig, R. A.
196 Crawford, J. C.
88 Crowell, E.
245 Croxton, J. M.
91 Cundell, H. G.
242 Curry, A. R.
30 Danenhour, G. B.
234 Davis, D. B.
224 Dechert, A. W.
129 Diniz, W. A.
151 Dodge, E.
132 Dodge, F. B. Jr.
240 Dodson, DeW.
201 Downs, S. H.
133 Drake, H.
100 Duffy, F. J.
127 Duryea, L. N.
122 Dusman, G. H.
174 Eagan, T. L.
81 Ellis, W. D.
238 Embree, J. H.
177 Everitt, W. L.
227 Everts, F. O.
33 Fairfax, C. C.
63 Falconer, R. B.
117 Ferguson, J. G.
161 Ferguson, M. W.
217 Fitz, H. I.
19 Fitzgerald, E. M.
165 Fitzpatrick, P. E
243 Fletcher, I. J.
171 Fleming, H. C.
93 Foster, E. W.
134 Franco, C. G.
208 Fratanduono, F. A
101 Friedlich, R. E.
84 Fuchs, F.
27 Gardner, J. A.
167 Gaus, A. R.
8 Gennis, M.
235 Gerken, E. R.
66 Gilman, J. T.
154 Greene, R. H.
60 Griswold, D. W.
78 Halperin, H.
169 Hammond, R. G
82 Harper, J. B.
22 Harris, L.
49 Hathaway, T. B.
150 Hawkins, R. Jr.
51 Heartfield, M. K.
79 Hendrickson, J. B.
145 Henry, G. L.
192 Hequembourg, E. G.
74 Hess, C. B.
175 Hight, C. B. Jr.
17 Hobbs, P. M.
35 Holmes, J. S.
136 Holmes, P. R.
160 Horton, H. D.
111 Howell, H. E.
140 Hudders, J. H.
246 Humphrey, R. F.
37 Hunkin, A. E.
181 Hutchison, J. A.
155 Jenkins, T. A. Jr.
28 Johnson, D. W.
13 Jones, A. S.
46 Karg, W. E.
64 Karsten, H.
184 Kearns, W. M.
120 Keller, B. D.
47 Kellogg, W. N.
156 Kennedy, C. E.
104 Kennedy, D. B. Jr.
4 Kerr, H. H. Jr.
2 Kevelson, M.
92 King, M. Jr.
102 King, T. F. Jr.
106 Kittredge, L. E.
189 Knauss, E.
90 Ladd, J. E.
114 Lardner, G. A.
119 Latz, L. M.
147 LeCluse, E. F.
187 Leonard, A. H.
97 Lewis, E.
70 Llewellyn, C. P.
31 Littlewood, W.
204 Lofton, M. C.
203 McCauley, W. T.
41 McCormick, A. L.
229 McDonald, A.
48 McDonald, D. L.
15 McDonald, J. M. Jr.
244 McFarland, R. B.
153 McGuire, W. S.
146 McVean, A. F.
1 Main, A. L.
103 Mallery, R. G.
142 Malmar, H. B.
61 Markthaler, L. V.
52 Martin, R. T. C.
23 Maurice, C. A. Jr.
87 Mayer, J. D.
152 Mead, G. S. V.
65 Mears, A. A.
233 Merrill, R. N.
183 Mertz, G. J.
210 Millard, D. H.
135 Minton, P. H.
96 Minty, J. E.
45 Molinet, E. R.
173 Mong, W. D.
220 Nash, E.
73 Neeland, C. J.
98 Nolin, A. R.
218 Ostrander, P. D.
144 Paddock, R. C.
71 Palmer, C. B.
12 Parrott, L.
226 Paul, S. H.
69 Payne, J. H. Jr.
230 Petrie, M.
209 Pierson, A.
42 Piester, C. J. Jr.
168 Pioso, R. L.
143 Pope, W. H.
157 Potts, G. C.
54 Previn, S.
9 Prieto, F. G. Jr.
72 Puder, J. W.
125 Purdy, R. B.
128 Quackenbush, L.
179 Quinan, W. H.
43 Rabi, I. I.
223 Reineman, H. H.
3 Riley, E. M.
109 Rinehart, M. C.
113 Rodemeyer, G.
94 Sachs, K. N.
38 Salisbury, M. E.
58 Samuels, H. P.
231 Schmidt, W. S.
159 Schneider, F. E.
118 Schwartzreich, S.
190 Sebree, E. B.
16 Seiter, J. E.
130 Shumway, H. L.
26 Simmen, G. P.
236 Smith, A. F.
14 Smith, Dean A. W.
247 Smith, E. B.
237 Smith, McN.
75 Smith, M. F.
67 Solomon, E.
36 Sovocool, S. M.
25 Spangberg, L. V.
182 Spicer, H. M.
21 Stanley, J. S.
212 Stevenson, W.
34 Stewart, H. H.
59 Stewart, W. D.
191 Strauss, J. N.
107 Suiter, V. D.
121 Suntay, A.
219 Swanson, S. B.
50 Swartwout, H. B.
89 Sweitzer, G. T.
205 Swirbull, L.
20 Taylor, R. L.
57 Tennygold, K.
126 Weinberg, M. B.
164 Weinheimer, C. M.
239 Weis, G. W.
53 Weller, D. M.
80 West, A. M.
110 Whittemore, A. S.
178 Whyte, K. C.
199 Wight, S. G.
198 Williams, V. J.
137 Wilson, M. L.
86 Winter, J. H.
7 Wohlwend, W. C.
5 Wolfertz, E.
185 Wood, C. W.
148 Wood, E.
112 Wood, K.
77 Wright, S. M.
39 Tompkins, W. D.
195 Tuttle, S. C.
10 Uriarte, E.
131 VanSweringen, R. A.
176 VanValkenburg, K.
170 Varona, M. C.
138 Velsey, R. D.
215 Voisinet, W. E.
172 Vroome, A. E.
213 Walker, A. S.
194 Walker, W. R.
40 Wallace, W. R.
105 Watters, R. J.
141 Weber, M. K.
44 Weil, E.

NUMERICAL LIST.

1. Main, A. L.
2. Kevelson, M.
3. Riley, E. M.
4. Kerr, H. H. Jr.
5. Wolfertz, E.
6. Clair, H. C. Jr.
7. Wohlwend, W. C.
8. Gennis, M.
9. Prieto, F. G. Jr.
10. Uriarte, E.
11. Carrino, C. N.
12. Parrott, L.
13. Jones, A. S.
14. Dean A. W. Smith
15. McDonald, J. M. Jr.
16. Seiter, J. E.
17. Hobbs, P. M.
18. Armstrong, J. B.
19. Fitzgerald, E. M.
20. Taylor, R. L.
21. Stanley, J. S.
22. Harris, L.
23. Maurice, C. A. Jr.
24. Acker, G. H.
25. Spangberg, L. V.
26. Simmen, G. P.
27. Gardner, J. A.
28. Johnson, D. W.
29. Colson, A. E.
30. Danenhour, G. B.
31. Littlewood, W.
32. Anderson, C. A.
33. Fairfax, C. C.
34. Stewart, H. H.
35. Holmes, J. S.
36. Sovocool, S. M.
37. Hunkin, A. E.
38. Salisbury, M. E.
39. Tompkins, W. D.
40. Wallace, W. R.
41. McCormick, A. L.
42. Piester, C. J. Jr.
43. Rabi, I. I.
44. Weil, E.
45. Molinet, E. R.
46. Karg, W. E.
47. Kellogg, W. N.
48. McDonald, D. L.
49. Hathaway, T. B.
50. Swartwout, H. B.
51. Heartfield, M. K.
52. Martin, R. T. C.
53. Weller, D. M.
54. Previn, S.
55. Aikins, J. R.
56. Brown, W. B.
57. Tennygold, K.
58. Samuels, H. P.
59. Stewart, W. D.
60. Griswold, D. W.
61. Markthaler, L. V.
62. Bell, J. S.
63. Falconer, R. B.
64. Karsten, H.
65. Mears, A. A.
66. Gilman, J. T.
67. Solomon, E.
68. Burt, R. C.
69. Payne, J. H. Jr.
70. Llewellyn, C. P.
71. Palmer, C. B.
72. Puder, J. W.
73. Neeland, C. J.
74. Hess, C. B.
75. Smith, M. F.
76. Cary, E. B.
77. Wright, S. M.
78. Halperin, H.
79. Hendrickson, J. B.
80. West, A. M.
81. Ellis, W. D.
82. Harper, J. B.
83. Byrd, R. H.
84. Fuchs, F.
85. Carney, C.
86. Winter, J. H.
87. Mayer, J. D.
88. Crowell, E.
89. Sweitzer, G. T.
90. Ladd, J. E.
91. Cundell, H. G.
92. King, M. Jr.
93. Foster, E. W.
94. Sachs, K. N.
95. Brogan, M. P.
96. Minty, J. E.
97. Lewis, E.
98. Nolin, A. R.
99. Alcus, F. L.
100. Duffy, F. J.
101. Friedlich, R. E.
102. King, T. F. Jr.
103. Mallery, R. G.
104. Kennedy, D. B. Jr.
105. Watters, R. J. Jr.
106. Kittredge, L. E.
107. Suiter, V. D.
108. Buschman, R. P.
109. Rinehart, M. C. Jr.
110. Whittemore, A. S.
111. Howell, H. E.
112. Wood, K.
113. Rodemeyer, G.
114. Lardner, G. A.
115. Clay, G. W. Jr.
116. Barkdull, R. E.
117. Ferguson, J. G.
118. Schwartzreich, S.
119. Latz, L. M.
120. Keller, B. D.
121. Suntay, A.
122. Dusman, G. H.
123. Bridges, H. O.
124. Craig, R. A.
125. Purdy, R. B.
126. Weinberg, M. B.
127. Duryea, L. N.
128. Quackenbush, L.
129. Diniz, W. A.
130. Shumway, H. L.
131. VanSweringen, R. A
132. Dodge, F. B. Jr.
133. Drake, H.
134. Franco, C. G.
135. Minton, P. H.
136. Holmes, P. R.
137. Wilson, M. L.
138. Velsey, R. D.
139. Burke, J. H.
140. Hudders, J. H.
141. Weber, M. K.
142. Malmar, H. B.
143. Pope, W. H.
144. Paddock, R. C.
145. Henry, G. L.
146. McVean, A. F.
147. LeCluse, E. F.
148. Wood, E.
149. Atwood, J. C. Jr.
150. Hawkins, R. Jr.
151. Dodge, E.
152. Mead, G. S. V.
153. McGuire, W. S.
154. Greene, R. H.
155. Jenkins, T. A. Jr.
156. Kennedy, C. E.
157. Potts, G. C.
158. Beveridge, J. M.
159. Schneider, F. E.
160. Horton, H. D.
161. Ferguson, M. W.
162. Carson, J. R.
163. Baer, W. D.
164. Weinheimer, C. M.
165. [illegible]
166. Carr, H. R.
167. Gaus, A. R.
168. Pioso, R. L.
169. Hammond, R. G.
170. Varona, M. C.
171. Fleming, H. C.
172. Vroome, A. E.
173. Mong, W. D.
174. Eagan, T. L.
175. Hight, C. B. Jr.
176. VanValkenburg, K.
177. Everitt, W. L.
178. Whyte, K. C.
179. Quinan, W. H.
180. Baer, W. A.
181. Hutchison, J. A.
182. Spicer, H. M.
183. Mertz, G. J.
184. Kearns, W. M.
185. Wood, C. W.
186. Buehler, L. Jr.
187. Leonard, A. H.
188. Christie, L. D.
189. Knauss, E.
190. Sebree, E. B.
191. Strauss, J. N.
192. Hequembourg, E. G.
193. Bixler, D. F.
194. Walker, W. R.
195. Tuttle, S. C.
196. Crawford, J. C.
197. Allen, E. W.
198. Williams, V. J.
199. Wight, S. G.
200. Ball, T. M.
201. Downs, S. H.
202. Aldridge, A. M.
203. McCauley, W. T.
204. Lofton, M. C.
205. Swirbul, L.
206. Beeler, C. F.
207. [illegible]
208. Fratanduono, J. A.
209. Pierson, A.
210. Millard, D. H.
211. Bleecker, W. G.
212. Stevenson, W.
213. Walker, A. S.
214. Covert, K. C.
215. Voisinet, W. E.
216. Armstrong, G. E.
217. Fitz, H. I.
218. Ostrander, P. D.
219. Swanson, S. B.
220. Nash, E.
221. Athans, G. E.
222. Arter, C. L.
223. Reineman, H. H.
224. Dechert, A. W.
225. Burk, R. M.
226. Paul, S. H.
227. Everts, F. O.
228. Allen, H.
229. McDonald, A.
230. Petrie, M.
231. Schmidt, W. S.
232. Bollinger, R. L.
233. Merrill, R. N.
234. Davis, D. B.
235. Gerken, E. R.
236. Smith, A. F.
237. Smith, McN.
238. Embree, J. H.
239. Weis, G. W.
240. Decken, DeW.
241. Clarke, W. H.
242. Curry, A. R.
243. Fletcher, I. J.
244. McFarland, R. B.
245. Croxton, J. M.
246. Humphrey, R. F.
247. Smith, E. B.

PROGRESS IN ELECTRICAL ENGINEERING*

By ALEXANDER GRAY†

In few fields of human endeavor have the pioneers lived to see the fruits of their labor in such abundance as in electrical engineering. The whole subject of electric lighting saw its beginning in this country with the work of Edison, Brush and Elihu Thompson all of whom are still actively at work.

Modern electric traction is but a development of the work started by Sprague 29 years ago, and the traction companies of this country now own over $5,000,000,000 worth of equipment, and have an annual income of over six hundred million dollars.

The first telephone line installed 39 years ago was four miles long, and the Bell Companies have now fourteen million stations which handle forty-two million messages daily over a network of thirty-three million miles of wire, and the articulation is now more distinct over four thousand miles than it was in the first installation over a distance of four miles.

Of the work in wireless telegraphy I shall only say that 20 years ago Marconi was able to read signals between two stations one mile apart. Today, in our little station in Franklin basement, we are able to read the German stations clearly and they are about four thousand miles away. We also hear all the wireless telephone messages that go out from Arlington, Schenectady and Pittsfield. Unfortunately, we have not the necessary equipment to enable us to talk back.

The other day I heard my little girl recite a poem by R. L. Stevenson, of which the first verse goes as follows:

> "My tea is nearly ready and the sun has left the sky;
> Its time to take the window to see Leerie going by;
> For every night at tea time and before you take your seat,
> With lantern and with ladder he comes posting up the street."

My wife and I, on comparing notes, found that we also had looked forward to the daily passing of Leerie the lamp lighter. Scotland is a land of gray clouds and dull weather, and the miserable little gas lamp is very cheerful, and yet today the streets are brilliantly lighted by electricity, and the whole thing is so commonplace as not to be appreciated until the service fails.

The remarkable thing about the work of the electrical engineer is that he does not see the stuff that he is handling. He moves a wire in front of a magnet and obtains what he calls a voltage between the two ends of the wire. He then makes up a circuit consisting of two leads and a filament which he calls a lamp, and then when he closes the switch the good Lord does the rest. Just why, or how we do not know, although the physicists blame it on little fellows called electrons which run along the wires. In fact, they have measured these electrons and find them to have a mass of 8×10^{-27} grams.

DEVELOPMENT OF STEAM CENTRAL STATIONS

In 1882 the first generating station in this country was installed by the Brooklyn Edison Company at Pearl street. The generators had a capacity of 125 H. P., which was considered so great in these days that the machines were known as Edison jumbos. This station supplied 25 customers, and had a connected load of 2323 incandescent lamps.

Even as late as 1888 a generator of 50 killowatts capacity was considered large, but a notable step was made in 1891 when the Brooklyn Edison Company installed 800 kilowatt units, which were direct connected to the engines in order to save floor space. By 1893 the size of the individual unit had grown to 1500 kilowatts, and a machine of this capacity was installed at the World's Fair of that year.

About this time the radius of distribution was beginning to extend rapidly, and the central station engineer recognized the advantage that alternating current had in that the voltage could readily be stepped up for transmission, and then stepped down on the customer's premises. Moreover, the alternating current motor invented by Tesla in 1888 was coming into use, so that the later stations are alternating current stations, and the size of the individual unit reached a value of 4500 kilowatts in 1898, and of 12000 kilowatt in the units of the Interborough Rapid Transit Company about 1905.

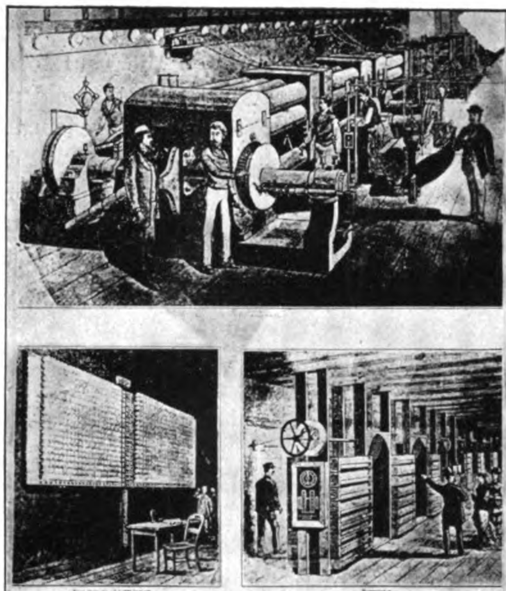
The steam turbine now began to make itself felt, and in 1902 a 5000 kilowatt Curtis turbine was built by the General Electric Company for the Commonwealth Edison Company of Chicago. Since that time the size of the station and also of the individual unit has increased until now we have in operation units of 40,000 kilowatt capacity, which is many times larger than some of the well known earlier stations. With this machine we leave the steam generating station. We do not look for any radical changes, but only for an increase in the size of the station and a decrease in the dimensions of the units required for a given output.

HYDROELECTRIC STATIONS

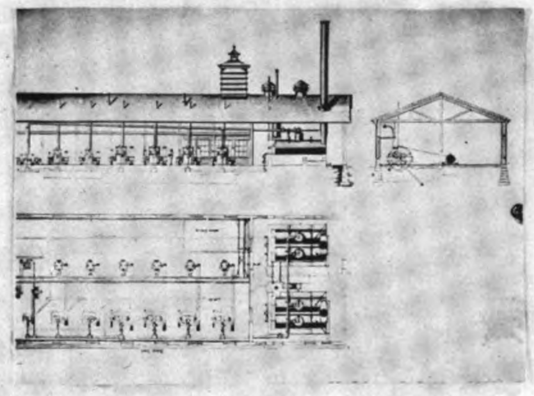
Parallel with the development of steam stations has been that of the hydroelectric station. The first one installed was the Appleton station by Edison in 1882, with a connected load of 250 incandescent lamps.

The next station of preeminent importance was the first Niagara station, for which the engineering work was commenced in 1890, and the water turned on in 1895. As an indication of conditions at that time (1890) it is of interest to note that while the consulting engineers had no difficulty in specifying the 5000 h.p. turbines, they were greatly concerned as to how the power developed should be made available at the factories, which were expected to grow up in the neigh-

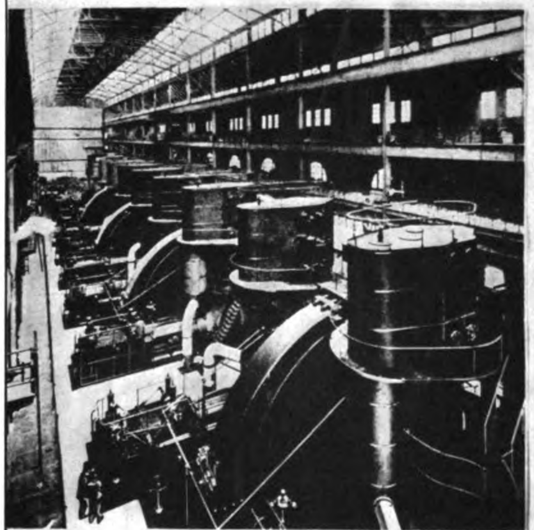
*Paper presented before Ithaca Branch of Sigma Xi Society.
†Professor in Electrical Engineering, Cornell University.



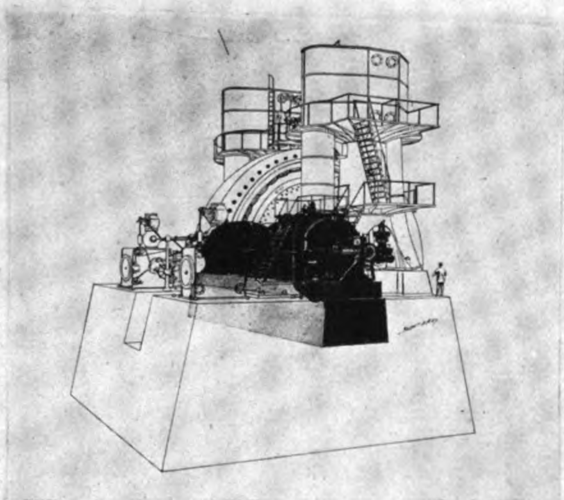
Early station with Jumbo generators



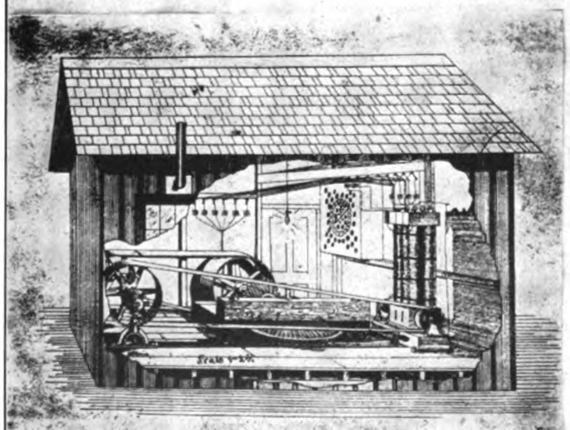
Early Station at East Liberty, Pa.



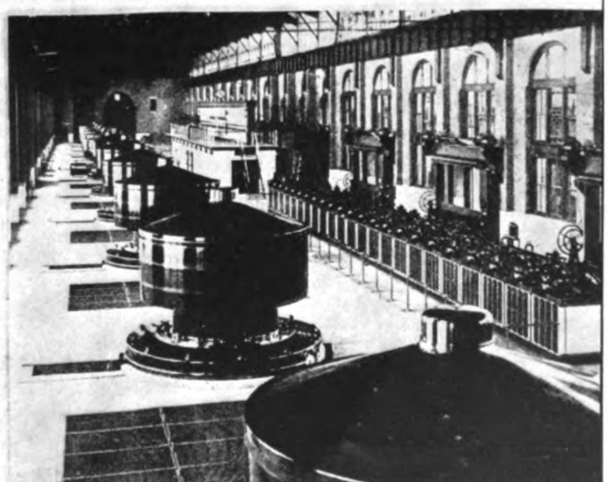
Interborough Rapid Transit Co.
12000 h.p. engines



Engine driven and Turbo units
of the same rating



Edison station at Appleton (1882)



Early Niagara station with
4000 kw. generators

borhood, and they seriously considered four methods of transmission.

(a) By wire ropes, a system that has been used at Schaffhausen to transmit large amounts of power for a distance of about two miles.

(b) By hydraulic power, the turbines in the Niagara gorge to drive pumps, and the high pressure of water to be used at the factory to drive small turbines. Such a system was in successful operation in Switzerland.

(c) By compressed air. A transmission of this kind over a distance of seven miles being in use in Paris.

(d) Electric transmission. This was finally adopted because of satisfactory results which had just been obtained by the Telluride Company, who had transmitted power a distance of ten miles over two bare wires strung on poles.

I can well imagine the tense feeling among the engineers who were present when the water was turned into the hydrants, and when the generators were thrown on the line, and the sign of relief when nothing happened; an engineer always says that nothing happens when things go as he had predicted, and the joy of the engineer is then as great as that of the research student who has made a new discovery, or of the sculptor when his creation stands complete.

Nothing very radical has been done since the Niagara station went in. The turbines and generators installed there had an efficiency which can hardly be exceeded.

It has been figured that there are about 150,000,000 h. p. of water power available in North America, and an equal amount in South America; there is 7,000,000 available in Niagara Falls. If we figure four pounds of coal per horse power hour then the water power of North America are equivalent to 26,000,000,000 tons of coal used per annum in the boilers of steam plants. All of this water power of course is not at present available, because of the high cost of the necessary development, but more and more of it will be brought to the service of man as the coal fields become depleted. One of the most remarkable of the recent developments is that at Keokuk, where a dam is built across the Mississippi River, and the waters of that river made to tumble through turbines and leave 200,000 h. p. behind.

POWER TRANSMISSION

The development of high voltage transmission lagged behind that of central stations until the time came, about 1890, when considerable amounts of power could be made available if only it could be transmitted to some large city.

Up until 1891 the most remarkable work done had been that of the Telluride Company who had transmitted power a distance of 15 miles at 5000 volts. In that same year a big step was taken when 200 h. p. was transmitted from Lauffen to Frankford a distance of over 100 miles, with only 30 per cent loss.

In 1895 we find that the engineers of the Niagara Company are seriously considering 10,000 volt transmission lines to Buffalo and 25,000 volt for greater distances, and in 1903, only eight years later, they were installing 60,000 volt lines. By this time the insulators had become so large that engineers had almost decided that the commercial limit of voltage had been reached, but in 1898 we find 100,000 volt lines being installed and we now have in operation about 250 miles of 150,000 volt lines. These two latter developments have been made possible by the invention and the improvement of the suspension insulator.

ELECTRIC TRACTION

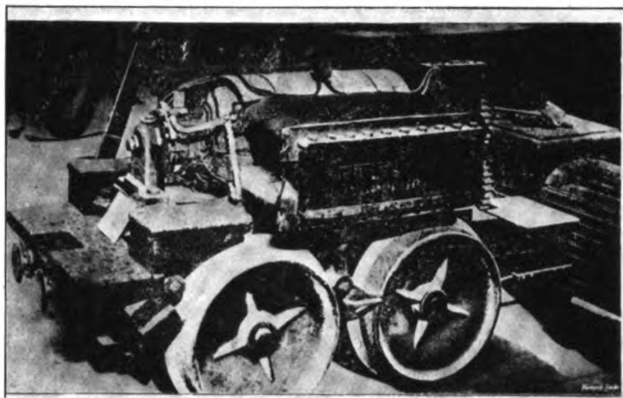
I well remember the controversy about 17 years ago in my home town of Edinburgh, Scotland, when the horse cars had become too slow for traffic, and it became necessary to adopt mechanical propulsion. Electric traction was proposed, but was finally turned down in favor of an endless cable system, because of the unsatisfactory results that had been obtained in America. The city of Edinburgh is built on seven hills, and the consulting engineers did not think that electric cars could mount the grades. Let us see then how electric traction in this country stood at that time.

The first system of city traction tried out was in Cleveland, where a line one and one-half miles long was installed in 1884, the conduit system being used. This line was not a success, and another conduit system installed in Boston in 1888 gave daily trouble, and was finally discarded in favor of the overhead trolley system, which had proven its worth a year before at Richmond, Va.

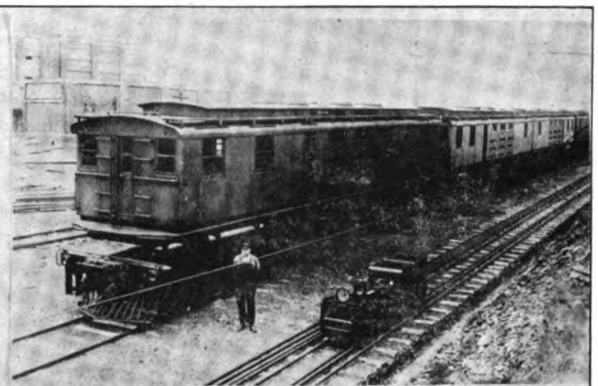
This system at Richmond is the first that was able to maintain reasonable service under rather bad conditions of curve and grade, and is a system on which the modern trolley lines are based. The difference between these early cars of 1887 and the cars of today can be appreciated when we are told that on its first trip the car at Virginia left the rails, and was pushed back again by the passengers. The motors also were not powerful enough, and a number of men had to travel on the back platform to be available to push the car around some of the sharp curves.

The motors being of the open type became water soaked. The brushes were of copper set at an angle, and they crumpled up every time the car backed. They say also that one could generally tell whether the car had passed or not by looking at the deposit of copper on the roadbed. The system was kept running, however, and maintained a regular schedule, and from that time onward there was no doubt about the future of electric traction.

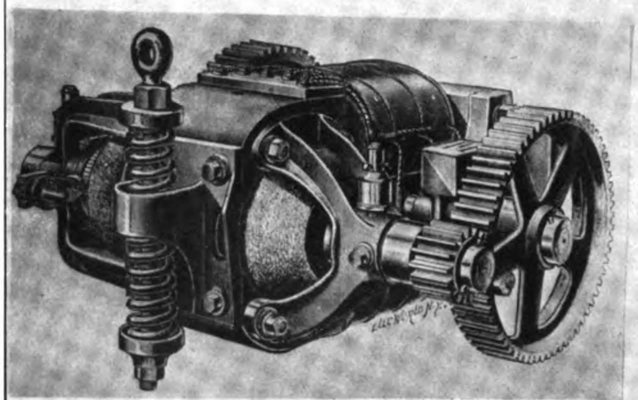
This Richmond system was gradually improved and by careful design and improvement in material the output of the motor was increased for the same space occupied. The next radical step was not made until 1897, ten years later, when Sprague introduced the multiple unit system in Chicago. This system is especially suited for rapid transit, where the cars are coupled together to form trains. If two or three trailers are added to a trolley car the train will finally refuse to start, because there is not enough dead



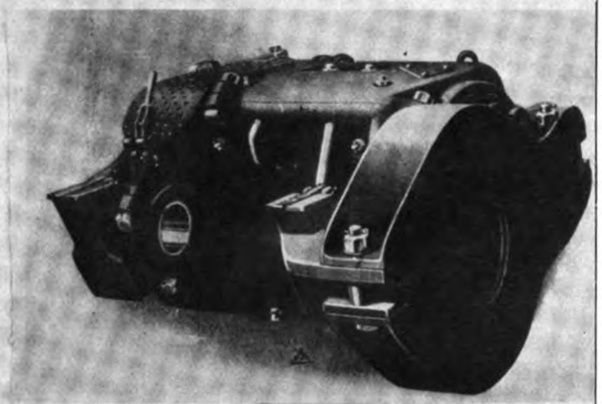
First successful electric locomotive
Siemens (1879)



280 ton locomotive of C.M. & St. Paul
with small mine locomotive adjoining

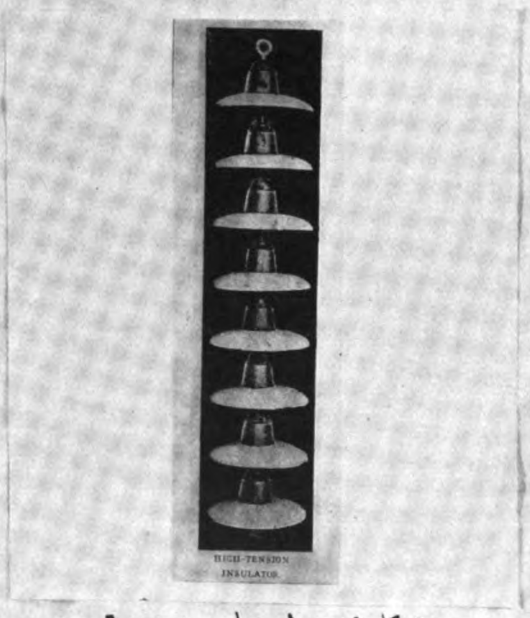


Early type of Sprague railway motor



Modern Railway motor

Pin Insulator



Suspension Insulator

weight on the drivers. With the Sprague system each car carries its own motors and the total weight of train and passengers is on the driving wheels. The problem Sprague had to solve was to operate all the motors simultaneously, and this was done by providing each car with its own controller and operating all the controllers in parallel by magnetic switches, excited from a master controller at the head of the train.

Electric locomotives were first used by Siemens in 1879, but the first locomotive to be put in regular and continual service was the ten ton, 100 H. P. locomotive, which pulled a three car train on the City and South London Railway in 1890. Five years later, in 1895, electric locomotives of 90 ton weight carrying 1440 H. P. were used by the B. & O. line to pull trains into Baltimore.

Nothing very radical has been done except to increase the voltage and to increase the weight of the locomotive. A 100 ton locomotive has an equipment of about 1400 H. P. and draws a full load current of 1500 amperes at 600 volts, and a starting current of twice that value. Collection of such currents from a trolley wire is practically impossible, and so the third rail system was used for these early locomotives. About 1911, however, the voltage was raised to 1200; two years later to 2400, and finally to 3000 volts on a 440 mile section of the C. M. & St. Paul Railroad. This increase in voltage, with a corresponding decrease in current, has made it possible to use the overhead trolley wire, the only satisfactory system for trunk line operation.

Another solution of the problem worked out by the New York, New Haven and Hartford Line is to consider the trolley wire as a transmission line, and the locomotive as a moving substation. In this system the trolley voltage of 11,000 alternating current is stepped down to 250 volts, at which it is supplied to single phase motors.

On the Norfolk and Western line, 30 miles long, the station on the car consists of a rotary machine which converts single phase power to two-phase power, which latter is then supplied to induction motors. Since motors of this type become generators if operated above synchronous speed without any change of connections, the trains on this system, running on the down grade, are used to supply part of the power for the trains coming up the grade. This regenerative feature is of particular value on the Norfolk and Western Line, since the loaded cars go down grade, while the empties go up. The C. M. & St. Paul system also has regenerative breaking, although the system is somewhat more complicated, since direct current motors are used.

It would be foolish for me to predict the advances that will take place in the next generation. It is certain, however, that so long as we obtain power from the sun's rays, through the medium of the old forests or of the water raised from the sea in clouds we cannot expect anything radical, since steam and hydroelectric stations have reached a high point of efficiency. The latest developments in such stations are not for the purpose of increasing efficiency but rather for maintaining service.

The indications are that the whole country within the next generation shall be tied together with a network of high voltage lines, which will be fed by large steam and water power stations, and tapped by consumers and by distributing companies as well as by the trunk line railways. The beginnings of such networks are at present in existence. The Southern Power Company has about 1400 miles of high voltage line, fed by six hydroelectric and two steam stations, and delivers over 120,000 h.p. to consumers dotted over 30,000 square miles of territory. The amalgamation of the Southern California Edison Company and the Pacific Light and Power Company joins together two systems with over 1400 miles of high tension line, some of which operates at 150,000 volts, which system is fed by five steam and thirteen hydroelectric power stations, with a total capacity of 280,000 h. p., and with 400,000 h.p. of water power still undeveloped. This system is tapped by 103 substations.

Not a few men owe the opportunity for advancement to their ability to write a good letter. Even though one be thoroughly versed in his subject and his discourse be well worth the time and attention of men of affairs, bad grammar will cast such suspicion over his whole equipment of learning that his argument will often be put aside without substantial consideration. But grammar is not a bar to the acquisition of money, but it substantially prohibits the acquisition of high position in the scientific world.—HARRINGTON.

The idea that a technical paper is dry at best, and that the English employed in it is of small consequence has long been proved incorrect. There is so much nowadays that is well written that no busy professional man is willing to spare the extra time and effort necessary to read and digest an ill written paper.—HARRINGTON.

Skill in making drawings is like skill in writing and figuring. Don't possess yourself with the idea that if you are unable to make a clear drawing, neatly lettered, it will be accepted as evidence that you are meant for greater things. You are more likely to succeed to other positions through skillful drawings. And as drawing is the natural way and the only way for recording much engineering thought, you ought to be able to draw well if you expect your thoughts to be clearly understood and to prevail.—HOWARD.

ENGINEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Gray, Prof. McDermott, Prof. Diederichs, Prof. Albert, Prof. Wells, Prof. Ellenwood· Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Lee, Asst. Prof. Pertsch, H. W. Brown, F. G. Tappan, F. L. Fairbanks, J. F. Wait.

The Sibley Journal will mail the magazines containing the articles abstracted to its subscribers at cost price.

Education in Engineering. Presidential Address, 1916, of Dr. D. S. Jacobus, *A. S. M. E. Journal,* January 1917.

Dr. Jacobus first states that in his opinion, the essential factors desirable in a young engineer should be given the following order of importance, as prepared by the Carnegie Foundation, for the Advancement of Teaching:

1. Character, integrity, responsibility, resourcefulness, initiative.

2. Judgment, common sense, scientific attitude, perspective.

3. Efficiency, thoroughness, accuracy, industry.

4. Understanding of men, executive ability.

5. Knowledge of the fundamentals of engineering science.

6. Technique of practice and of business.

He then points out the important truth that this list would apply almost equally well for any profession, and that character very properly heads the list. But as he says "It would be a dangerous conclusion for a young man to feel that his success is assured if he has character and the other qualities which come near the head of the list, and that it is not necessary for him to have thorough knowledge of the technique of his profession.

Such an unfortunate would soon find that the ethical qualities alone will not earn his bread and butter, and that a lack of knowledge in his profession will be an immense handicap.

There might still be "something" lacking in the young engineer, who, qualified under the Carnegie list. This "something" is necessary for success and includes such qualities as:

Taking a personal interest in one's work.

Amenability to discipline.

Perseverance under adverse circumstances.

Cheerfulness and amity—the human side.

The author then discusses quite fully each of the four qualities; then he discusses the methods of teaching, bringing out the fact that teaching methods are not the cause of failure in many cases, but that "a way never has and never will be found to acquire knowledge without study and much of the trouble experienced by some students arises through a lack of study or a failure to appreciate the fact that the fault is their own."

He then shows how the engineering professor, who is engaged in outside work, may also do excellent work in his classroom. He next discusses the importance of experimental investigations, preparation of scientific papers, and the issuance of reports. In each of these things the engineer must be extremely careful to stick to the exact truth and "not to testify in a way which will evade the truth."

He then discusses the question of shortening college courses, and states that in his opinion "it is a mistake to make the entrance requirements too high for an engineering college."

He summarizes as follows:

1. That there be a closer co-operation between the engineering colleges and those employing graduates, and that the engineering societies be encouraged to work along this line.

2. That the technical requirements for entrance to colleges be lowered rather than raised, that preparatory schools be encouraged to give more attention to teaching good English and to giving a broad general education, and that applicants be also judged as to their initiative and general make-up in deciding whether they should be admitted.

3. That the courses be so arranged as to train the initiative and develop the human side; that the students be taught to work in a cheerful and efficient way; that there be proper time for daily relaxation of the mind and that the students be encouraged to use this time to the best advantage.

4. That the professors get down to hard work with their students and know all of them well enough to be thoroughly acquainted with their personal characteristics.

5. That the professors in practical subjects have practical experience so that they can speak with authority.

6. That professors in charge of practical engineering departments be encouraged to undertake practical engineering work, and that their college work be so arranged that they can be relieved from meeting classes when the engineering work makes this necesssary.

7. That special attention be given to teaching the fundamentals of engineering science, even though this may result in the elimination of certain specialized branches.

8. That greater practice be given in the writing of concise and logical reports in good English, and in speaking on one's feet.

9. That the students be encouraged to confer with the professors, and that regular hours be provided for

this purpose, all to the end that the teachers may extend a helping hand where needed and that there be a mutual understanding and trust.

F. O. E.

Oil Burners and Furnaces, by W. H. Russell, in the *National Engineer* for January, 1917.

The burner utilizing the least amount of energy in bringing about a perfect atomization of the fuel oil at a minimum first cost is considered the most efficient. This atomization is accomplished either by some mechanical means, or by the use of steam or air. By the first of these two principles there are two methods employed; one by a small electric motor which revolves a disc at a high rate of speed and breaks up the oil into a combustible form by centrifugal force; the other by forcing the oil under a high pressure and temperature through a specially designed head which by mechanical action separates the oil into a fine mist.

There are two types of burners using steam or air for atomization, the one which causes the oil and steam to mix upon the inside, called an inside mixer, and the other where the mixing is effected upon the outside and called an outside mixer.

Any burner will produce the best results if the oil is heated to about 125 degrees, as the heating lowers its viscosity so that it responds more readily to separation, and in consequence requires less steam or air for atomization. It is not advantageous to heat the oil above its flash-point, as troubles occur by carbon being deposited in the coils and pipe lines, and at the burner tip.

The oil and steam passages of the outside mixing burner are small and give a great deal of trouble by becoming clogged with particles of scale and other foreign substance. When this occurs the burner must be taken out and cleaned. Then again, the tip becomes sufficiently hot to cause carbon to deposit around the mouth, which will direct the flame against the shell of the boiler.

When the mixing takes place upon the inside, the passages can be made large enough to prohibit the possibility of its clogging by small particles, and as the movement of the oil is more rapid at the hottest point, the danger of its carbonizing is considerably lessened.

Economy in the use of fuel oil depends as much upon the construction of the furnace as upon the burner itself. A burner that will form a perfect atomization of the oil will give very poor results in a furnace improperly designed.

The principal points to bear in mind in building an oil furnace are to see that the combustion chamber is sufficiently large and that the air is admitted to the burner in such manner that every atom of oxygen is consumed. This is where the greatest loss occurs in the majority of cases, as, for instance, should the combustion chamber be too small for the steam generated, the combustion will take place at the rear of the boiler, through the tubes, at the front and in the breeching. This combustion is imperfect, due to the restricted chamber which prevents a perfect mixture of the air and gas. The flow of the gases of combustion will be more rapid in a restricted chamber, causing a very high stack temperature, while the furnace is comparatively cool. Then again, should the chamber be ample for complete combustion, yet the air for combustion be admitted in such a manner that a perfect mixture is prohibited, the excess air will flow along the sides and bottom of the shell. This air absorbs the heat of the furnace, lowering its temperature, and prevents a more perfect combustion.

Some engineers carry the air ducts along beneath the floor of the furnace for the purpose of preheating the air, as well as having a coil of pipe or some other means placed in the furnace for superheating the steam. The advantage of the superheated steam and preheated air is that it maintains a higher temperature at the point of combustion. If the air for combustion could become heated by absorbing the heat from the waste gases, instead of stealing it from the furnace, a real saving in oil would result.

Too much care cannot be exercised in ascertaining the condition of the furnace wall. The bricks are porous and the walls should be given a coat or two of paint, or some other medium which will adhere to and stop completely the pores of the bricks. In old walls every tiny crack should be filled. A good way is to cover the walls with an asphalt paint, then mix some of the paint with slacked lime into a putty and with this stop up every crack. Then in a day or two give it another coat. Every particle of air entering the furnace should enter through the draft doors, where it can be controlled.

The fire brick for the arch and linings should be put together with a high temperature cement.

C. H. B.

Industrial Controllers by H. D. James. *The Electric Journal* January, 1917. This is the first of a series of articles by the author on this subject.

An electric controller is essentially a part of the motor, designed to perform functions not incorporated in the motor design. The following functions are customary:

Current is limited during Motor acceleration, by inserting resistance in the armature circuit, so that $I = \frac{E_L - E_C}{R}$ where I is the allowable current, E_L the line e.m.f., and R the resistance of rheostat, armature and line, in the armature circuit. As the speed increases and E_C approaches E_L, the resistance must be reduced.

Torque is limited during acceleration by starting with zero field. The electric torque exerted by the motor is proportional to armature current and field strength. When the field circuit is closed it takes an appreciable time for the field to build up, so that the torque is built up gradually and there is no sudden jolt in starting.

Direction of rotation is reversed by reversing the armature current of a D. C. motor; by interchanging

any two leads on a three-phase motor; or by interchanging two leads in one phase of a two-phase motor. If the motor is reversed frequently, some substantial form of reversing switch is required.

Motor load is limited by fuses or a circuit-breaker—preferably provided with a time element attachment allowing the motor to take a peak load of a second or so without opening the circuit.

Motor is disconnected upon failure of voltage by a latch or other device held in place by a shunt magnet. When the line voltage fails, the controller is released and returned to the off position.

Motor Speed is Regulated:

(a) By armature control. A resistance in the armature circuit of a D. C. motor makes the voltage across the motor brushes less than line voltage, and reduces the speed. The speed of wound secondary induction motors is similarly reduced. In either case a change in torque changes the RI drop and therefore the speed; so that the result is "**variable** speed motors."

(b) By field control. A rheostat connected in series with the shunt field winding changes the speed; but the speed is practically independent of torque, resulting in "**adjustable** speed motors."

(c) By changing the voltage of the supply circuit. For this purpose each motor is usually supplied with a separate generator. This is suitable for large motors, principally for mine hoists and steel mills.

Motor is stopped and started at fixed points in a cycle of operation by "limit switches," operated by the machinery to which the motor is connected. Usually these switches interrupt only a small circuit, thereby opening magnetic contactors which in turn disconnect the main motor circuit.

Motor is stopped by braking:

(a) By mechanical braking, in which case a heavy spring is released by a magnet connected in the main circuit, which sets the brake when there is no motor current.

(b) By dynamic braking, which is accomplished by disconnecting the armature from the line and short-circuiting it on itself through a resistance, with the field at its full strength.

Operator is protected from shock, burning, or mechanical injury, by automatic or other safety devices, adapted to each particular application.

H. W. B.

The American Machinist is now running a series of articles on **United States Munitions** in which descriptions and illustrations of the processes of making the various details of the modern service rifle are given. A similar series of articles on **The Making of a Typewriter,** by Frank A. Stanley, also appeared in recent issues.

C. W. H.

A Book on the Looks and Details of Machines, by John E. Sweet, is being given in installments, beginning with the December 7th issue of the *American Machinist.* This material was left in manuscript form by Professor Sweet at the time of his death. This hitherto unpublished book manuscript is a collection of details and devices that in Professor Sweet's experience were "the best way to do certain things."

C. W. H.

Safe and Noiseless Operations of Cut Gears, by William Knight, *American Machinist,* December 14, 1916.

In this article he presents an investigation of experimental results and authoritative studies on the design and operation of cast-iron gears. The cause of noise is discussed, and a formula for reduction of tooth height to avoid interference is given. Charts for safe load factors are presented, durability is considered, and formulas for thickness of the side plates and heating effect of rawhide gears are given.

C. W. H.

L. P. Alford discusses at length a meeting of the **New York Industrial Congress** in the *American Machinist* of December 21, 1916.

The first congress held under the auspices of the Industrial Commission of the State of New York devoted four days to a discussion of accident prevention and health preservation. The spirit exhibited throughout was that of the pioneer—one who bravely and vigorously attacks a great problem of human suffering and economic waste.

C. W. H.

Change in S. A. E. Thread Standards, *American Machinist,* December 28, 1916.

We believe that many of our readers will be interested in a slight change that has been made in the S. A. E. standards for screws and bolts.

Some difficulty has been experienced because of the short length of thread formerly provided on the bolts. This length was 1½ times the diameter of the bolts, and it was found that many bolt makers were in the habit of providing even less full thread, measuring the thread to the extreme point that had been marked by the die. The inconvenience was particularly apparent when the bolts were used in connection with castings that were spotted at drilled holes and not finished accurately to thickness. Because of these things the standard was changed to require that the *effective* thread shall be 1½ times the bolt diameter plus ¼ inch. It is believed that this new standard will provide sufficient leeway to meet the needs and that the difficulties, spoken of above, which have been previously encountered will be overcome in future manufacturing.

C. W. H.

The Utilization of Waste Heat for Steam Generating Purposes, by Arthur D. Pratt in the December 15th and January first issues of *Metallurgical and Chemical Engineering* shows the advance in the field during the last few years. With the most recent design of boiler it is possible to successfully generate steam from gases whose temperatures are as low as 950 or 1000 deg. Fahr. This was regarded as impossible a few years ago.

The sole theory, on which the early types of waste-heat boiler installations were made, had as its basis the non-interference in operation of the primary furnace. This meant minimum resistance in every section of the boiler, in order that a stack of reasonable height might be employed to produce the necessary draft. Even baffles were an oddity in such boilers.

Experiments have shown that the rate of heat transfer is dependent upon gas velocity and temperature and that with even the highest of velocities the effect of increased temperature differences is small compared with that of increased gas velocity.

In order to give the necessary velocity, to the gases at low temperature which will give a desirable transfer rate, the friction through the waste-heat boiler is so increased as to render the production of draft by stack impracticable. Induced draft systems were therefore installed and found to produce the desired velocities thus enabling the utilization of low temperature gases. The maximum amount of power required for driving the necessary fans on one set of tests was found to be but two per cent of the total power generated by the boiler while the average was 1 55 per cent.

Open-hearth steel furnaces have up to the present been the largest field for waste-heat work and in this article details are given of the construction of such boilers. For this class of work alone over 90,000 rated boiler horse-power has been installed or ordered. Because of their special design and necessary fans, flues, structural material, etc., they have a very high first cost but it has been shown that they will bring, as a conservative estimate, a return on this investment of 60 per cent.

An article by Professor R. C. Carpenter in the SIBLEY JOURNAL OF ENGINEERING, March 1904, on a waste-heat boiler of the Wickes type at the Cayuga Lake Cement Company's plant is quoted as being the first waste heat boiler used with a rotary cement boiler. Since the installation of this first boiler many other cement plants have utilized their waste heat in a like manner. At one plant approximately 60 per cent of the total steam requirements is furnished by four waste-heat boilers and 100 per cent more of the cement dust is recovered than when the boilers were not used.

The several variations in design of waste-heat boilers for copper furnaces are also described. In this case the saving was found to be of an approximately equal magnitude to those previously described.

Waste-heat boilers with Beehive Coke Ovens are described and the approximate results obtained are given. It was pointed out that even assuming that the Beehive Ovens will ultimately be replaced with by-products ovens, the installation of waste heat boilers would pay for itself many times before such a change could be made. It would also be possible to design these waste heat boilers so that they could easily be adapted to the new circumstance after the alteration had been made.

The waste-heat boiler while applied in main to the above mentioned industries has also found a field in connection with the following: Zinc furnaces, nickel-refining Furnaces, Gas Benchs and Oil Stills.

J. F. W.

Erosive Effect of Steam on Turbine-Blading Material, by Lieutenant (J. G.) T. J. Kelleher, U. S. N., in the November issue of the *Jouraal of the American Society of Naval Engineers.*

Results of a research problem in the summer course in the Post Graduate Department of the Naval Academy.

The apparatus used was a brass box nine inches by nine inches by nine inches, which acted as an exhaust chamber and contained the blade holders and blades, which were stationary and placed at an angle of ten degrees to the nozzles in order to avoid the spattering effect. On the front of the box was a steam chest containing expanding nozzles designed for a hundred pounds gage pressure and twenty-seven inch vacuum. A throttling calorimeter was used for the purpose of obtaining the quality of the steam.

Due to the difficulty in obtaining blading material, there were certain dissimilarities in the dimensions of the pieces tested, particularly in the cases of the steel specimens. Inasmuch as the erosion is principally on the entrance edge of the blading, these discrepancies in blade width and thickness vitiate the weight losses when determined as percentages of the original weights of the specimens.

Examining the table of weight losses it appears that extended brass stood up best under the 3,400 foot-second velocity with steam quality of 87 per cent; having a percentage loss of 0.121, monel following with 0.273 and steel with 0.386. The comparison between steel and the others is hardly a just one, for the reason that its width and thickness were less. In general there appears to have been no particular uniformity in the amount of erosion during the different periods, although the percentage loss per period of cupro-nickel and Parsons metal reduced more or less uniformly.

NAME	Grams Original Wt.	Inch Original Width	Wt. Percent loss 1st 3½ hours	Wt. Percent loss 2d 3½ hours	Wt. Percent loss 3d 3½ hours	Wt. Final Percent loss 10½ hours
Extruded brass	7.0135	0.6015	0.07	0.02	0.03	0.121
Rolled brass	8.0090	0.5935	0.63	0.47	0.53	1.610
Rolled cupro-nickel	9.4925	0.6342	0.87	0.81	0.77	2.435
Monel	8.5951	0.6224	0.01	0.15	0.12	0.273
Parsons	5.6835	0.6021	2.46	2.03	1.04	5.435
Steel	3.4995	0.4584	0.21	0.05	0.13	0.386

RUN No.	Steam Press lbs. Gage	Vacuum Inches	Steam Quality	Quality at Blade Entrance	Velocity Ft. Seconds
1	100	22.7	99.28	87.40	3,420
2	100	22.6	99.00	87.15	3,410
3	100	22.8	99.06	87.20	3,415

C. R. M.

UNIVERSITY NOTES

"The Personal Relation in Industry" was the subject of a lecture delivered in Bailey Hall on Founder's Day, January 11, 1917, by John D. Rockefeller, jr. Mr. Rockefeller, having had much practical experience in dealing with labor troubles, is well known as a speaker on the relations between the employer and the employed.

On account of the late opening of the University this fall, there was no holiday, as usual, upon this occasion, but a convocation hour at twelve.

Ground has been broken for the new student dining halls, which will be located directly west of the Library between West and Stewart Avenues, somewhat nearer Stewart than West Avenue. In time they will be completely surrounded by buildings of the dormitory unit.

Professor Dexter S. Kimball, on the evening of January 8, 1917, delivered before the student branch of the A. S. M. E., at the second meeting of the year, a lecture on "The Problems of Practicing Engineers." In his talk, which contained numerous illustrations drawn from his own personal experiences in the engineering field, both as a designer and as a consulting engineer, Professor Kimball outlined in an extremely interesting manner, some of the many problems which might confront a man following the mechanical engineering profession, and for solutions of which he might be called upon. Professor Kimball is a man of wide experience, and an interesting speaker, and is thus eminently fitted for giving a lecture of this nature.

The Aero Club of America, for the purpose of interesting college men in aeronautics, has offered three medals of merit to each of the fifty leading universities, Cornell being one of those on the list. These will be awarded to the three students in each university who present the best original essays on military aeronautics, mechanics of the aeroplane and possible technical developments in aeronautics, and possible application of aircraft to utilitarian purposes. All essays must be in the hands of the secretary of the Aero Club on or before March 15, 1917.

The interest in the local Aero Club, which was in existence two or three years ago, has gradually died out, but it is expected that steps will be taken in the near future for the purpose of reorganizing the club.

Certainly, there are other things, other characteristics that will be determining factors later, but for your immediate future nothing is more important than neatness. Neatness is evidence of carefulness, and carefulness of accuracy.—HOWARD.

An educated man with all his vast knowledge and refined emotions is a failure unless his will is trained to do what he knows and feels he ought to do.—KARAPETOFF.

OBITUARY

Joseph Sterling Goddard, '94

Joseph Sterling Goodard, M.E., '94, after a week's illness, died at his home in Riverside, Ill., on November 23, 1916, of pneumonia.

Mr. Goddard was born August 15, 1872, at Monroe, Michigan. After studying in the Chicago Manual Training School, he entered Sibley College in 1890. He was one of the founders of the Cornell chapter of Sigma Phi. After he was graduated in 1894 with the degree of Mechanical Engineer, he entered the employ of the Burlington Railroad Company, of which firm he later became chief draftsman. This office he resigned in 1907 in order to become chief engineer of the American Steel Foundries at Chicago. He was married to Miss Ellen Ware in 1905. He had been president of the high school board in Riverside. His wife and five children survive him.

Walter Edward Guldi, '18

Walter Edward Guldi, a member of the Junior class in Sibley College, and his father, were both killed in Sayville, N. Y. on the night of December 25, 1916, in a most horrible accident. Young Guldi and his father, together with an older brother, had just left their place of residence in an automobile on the way to Mr. Guldi's store, after having returned home with the family from New York, where they had spent Christmas day. The machine, with Guldi driving, had gone barely two hundred feet, when, without warning, it was struck by a Long Island Railroad train at a crossing. That they were not on the lookout for the train was due to the fact that it was fully twenty minutes after train time, and because the car was enclosed, and was running with the cutout open, the occupants knew nothing of the approaching engine until it was upon them. The car was carried about four hundred feet. All three of the occupants were thrown upon the pilot of the locomotive. When picked up both Guldi and his father were dead. The brother escaped death, but was seriously injured.

Guldi was born on November 12, 1897, in Brooklyn, N. Y. He was the second son in a family of four sons and three daughters. His preparatory training was received at the Sayville High School. He entered Sibley College in 1914, and had made a good record in his studies while here. He was a young man of excellent character and high morals and was well liked by the many friends whom he had made in Ithaca.

Clebron Wood Palmiter, '14

Clebron Wood Palmiter, '14, died at his home 128 Winthrop Street, Watertown, N. Y., on November 6, 1916.

EMPLOYMENT NOTES

289. Mr. J. A. McNulty, Joseph T. Ryerson and Son (iron, steel machinery), 30 Church Street, New York City, wants recent graduates to enter the iron and steel business.

290.* A partner is wanted to invest $3000 to $5000 in a nozzle and burner business. Wide variety of applications. The owner has had 12 years' experience and is A1 mechanic but wants assistance in pushing the business.

291. Mr. T. L. Tomlines, Flower Bldg., Watertown, N. Y., wants man at once for office work connected with structural design, layout of plant, etc., for paper pulp mills. Great variety of work covered.

292. Durand C. Alexander, '01, General Manager of Quasi Arc Weldtrodes Company, 61 Broadway, New York City, wants high grade men of good personality and responsibility who have had about eight years' experience, some preferably in plate work (boiler, ship, etc.) where electric welding is applicable. This concern has just acquired the United States rights of a well established and successful English business. The men selected would be sent to England for a short time, with view to preparing for such positions as chief engineer, division engineers, etc. Good salary for properly qualified men, with excellent prospects ahead.

293.* A man is wanted for laboratory and development work connected with the steam power plant of an automobile. Man should have had several years' practical experience, and experience in conducting laboratory work.

294. William F. Hunt, Consulting Engineer, care Portage Hotel, Akron, Ohio, knows of openings in a large company in Akron, for graduates with some shop and drafting experience.

301. Mr. P. W. Thompson, Industrial Secretary of the Cornell University Association of Michigan, knows of an opening in the sales department of the Hyatt Roller Bearing Company of Detroit, for a man who has been out of college one or two years. For particulars, write to Mr. P. W. Thompson, 18 Washington Ave., Detroit, Michigan.

303*. There is a good opening for a 1916 man in a large and rapidly growing rubber concern in Akron, Ohio. Work connected chiefly with problems in export business but with excellent opportunity to become thoroughly acquainted with the rubber business.

304. Mr. Harry M. Pierce, Chief Engineer, E. I. duPont de Nemours and Company, Wilmington, Del., is reported to be looking for mechanical engineers with good practical experience either in design or construction, preferably connected with chemical work. Wants men who have been five or ten years out of college.

*Address applications to this number, care of Sibley Employment Bureau, for forwarding.

305. There are many openings in Detroit. The Engineers' Club of Detroit could place twenty men, the Y. M. C. A. nine and the Executives' Club four. Many of the openings are attractive. The Executives' Club is especially after men for efficiency work and as factory functional executives. Address the above mentioned clubs, or H. H. Crane, employment secretary Board of Commerce, Detroit.

306. Mr. S. B. Trainer, Secretary of the Canadian Milk Products Limited, Mail Building, Toronto, Canada, has opening for young mechanical engineer to take charge of the engineering department of their business.

307. Mr. W. D. Murray, 76 William Street, New York City, wants a man to take charge of the electrical department of Robert College, Constantinople.

308. Mr. M. W. Morehouse, Superintendent Mergenthaler Linotype Company, Brooklyn, N. Y., wants man with two or three years' experience in light manufacturing. Experience in automobile or similar class of work preferred.

311. Mr. D. V. Lyle, Assistant Engineer, the Pennsylvania Company, Pennsylvania Station, Pittsburgh, Pa., wants rodmen and chainmen.

312. Robert C. Baldwin, Vice-President and secretary C. Lee Cook Manufacturing Company, Louisville, Ky., wants recent graduate in a business connected with the development and manufacturing of mechanical devices and machine tools.

313. W. S. Carpenter, Jr., '10, Assistant Director, Development Department E. I. duPont de Nemours Company, Wilmington, Del., wants several men who have had at least five years' experience, preferably those who have been in touch with the mechanical end of chemical industries.

323.* An eastern railroad wants an electrical engineer to have supervising charge of all power house equipment, all shop electric equipment and lighting of passenger train cars.

324. Mr. E. R. Martin, Employment Manager, Curtiss Aeroplane and Motor Corporation, 65 Churchill St., Buffalo, N. Y., writes that owing to certain changes in organization there may be some openings particularly in the Engineering, Inspection and Research departments of this firm.

325. Mr. J. J. Serrel, '10, Vice Pres., Smith-Serrel Co., Inc., 90 West St., New York City, General Sales Agents for Francke Flexible Coupling for direct connected machinery, wants recent graduate of good personality and appearance for road work along lines of publicity and demonstration as preparation for advancement in rapidly growing business.

335. The Bell Telephone Company of Pennsylvania wishes to engage a mechanical engineer who has had experience with automobiles and trucks. The position offers an opportunity to become familiar with various types of automobile machinery and appliances; to design special equipment and make tests on internal combustion engines, fuels and lubricating oils. The work will be in Philadelphia. Apply to Mr. H. N. Reeves, Supervisor of Supplies and Motor Vehicles, 1230 Arch Street, Philadelphia.

PERSONALS

George Bullock, '83, holds the office of president of the Susquehanna Railway & Light Power Company, 40 Wall Street, New York City.

W. B. S. Whaley, '88, is a consulting engineer with office at 136 Federal Street, Boston, Mass. He is at present in China.

William Dalton, '90, has resigned as chief engineer of the American Locomotive Company of Schenectady, with whom he has been for 22 years, to become general manager of the Washington Steel and Ordnance Company of Washington, D. C. Mr. Dalton was quite prominent in the civic life of the city, being a member of the board of trade, an advocate of all movements for civic improvement, a trustee of the Schenectady Savings Bank, and a director of the Mohawk Bank.

When the company took up the manufacture of munitions at the outbreak of the present war, Dalton went to Providence to assume charge of the plant. The prominence taken by the company in the munition field, and the recently declared dividends show the result of his work and efficient organization. He invented new machinery and devised entirely new methods for the manufacture of war material.

S. D. Locke, Jr., x '93, is secretary of the Locke Steel Belt Company, Bridgeport, Conn.

H. H. Alcock, x '96, formerly a director of the Inter-Ocean Steel Products Corporation, of New York City, is now with the New England Westinghouse Company. His address is Box 472, Springfield, Mass.

William S. Austin, '96, has become chief engineer of the Symington Company of Rochester, N. Y. Until recently he was with the Eastman Kodak Co., acting in the same capacity.

Charles L. Inslee, '96, is president of the Guaranty Construction Company, 140 Cedar Street, New York City.

C. M. Chapman, '99, is with Westinghouse, Church, Kerr & Company, 37 Wall Street, New York, as an engineer.

John W. O'Leary, '99, has been re-elected president of the Chicago Chamber of Commerce. The nominating committee and the board of directors deemed it inadvisable to dispense with his services, because they wished him to supervise the completion of several undertakings begun by the association during his administration. Mr. O'Leary is the second chief executive who, in the history of the association, has been called upon to serve a second term.

Henry T. Coates, '00, formerly with the Pennsylvania Railroad, is now president of the Philadelphia Brass Company. Coates has changed his address to East Downington, Pa.

Continued on page 12, Adv. Section

BOOK REVIEWS

Elementary Chemical Microscopy. By Emile M. Chamot, B.S., Ph.D., Professor of Sanitary Chemistry and Toxicology, Cornell University. 410 pages 6 x 9, 138 figures. Cloth, $3.00. John Wiley & Sons, New York.

As Professor Chamot points out, in the preface to his valuable contribution to literature, the American scientist is somewhat backward in accepting the benefits to be gained through the intelligent application of the chemical microscope. A book, therefore, which points out the many uses and possibilities of "microscopic methods" is a book which ought indeed to be in the possession of every American scientist.

This book is very thorough and goes into moderate detail in treating of the structure of the instruments and gives the rudiments of the underlying theory. It also gives a number of interesting examples of its uses in the arts. The book is divided into fifteen chapters treating of the following subjects:

Objectives and Oculars. Microscopes for use in Chemical Laboratories. Illumination of Objects. Illuminating Devices. Ultramicroscopes. The Examination of Opaque Objects, Vertical Illuminators. Metallurgical Microscopes. Useful Microscope Accessories, Laboratory Equipment, Work Tables, Radiants. Micrometry. Micrometer Microscopes. Polarized Light. The Polarizing Microscope. Crystals under the Microscope. Determination of Refractive Index. Quantitative Microscopic Analysis Microscopic Determination of Melting and Subliming Points. Methods of Handling Small Amounts of Material. The Methods of Microchemical Qualitative Analysis. Characteristic Microchemical Reactions of the Common Elements when in Simple Mixtures. Preparing Opaque Objects for the Microscopic Study of Internal Structure.

Handbook of Formulas and Tables for Engineers. By Clarence A. Peirce, Assistant Professor in Power Engineering and Walter B. Carver, Assistant Professor of Mathematics at Cornell University. Second edition revised and enlarged. 188 pages. Price $1.50 net. McGraw-Hill Book Company. New York.

In the second edition of this little handbook the few errors which appeared in the edition have been corrected and a small amount of new material has been added. The additions consist mainly of the paragraph on the laws of exponents, the formula of hydraulics, tables of natural logarithms and hyperbolic functions, an abbreviated reproduction of the Ellenwood steam charts and a table of steam properties made up from Marks and Davis tables.

The authors were wise enough to resist the "inevitable temptation" to expand the book into a large volume and it well fills the position of a small book of really convenient pocket size and exceedingly well adapted to the needs of students in Sibley College. The book has also been found to be of some use to practicing engineers and students in other universities.

CAMDEN

You Will Buy

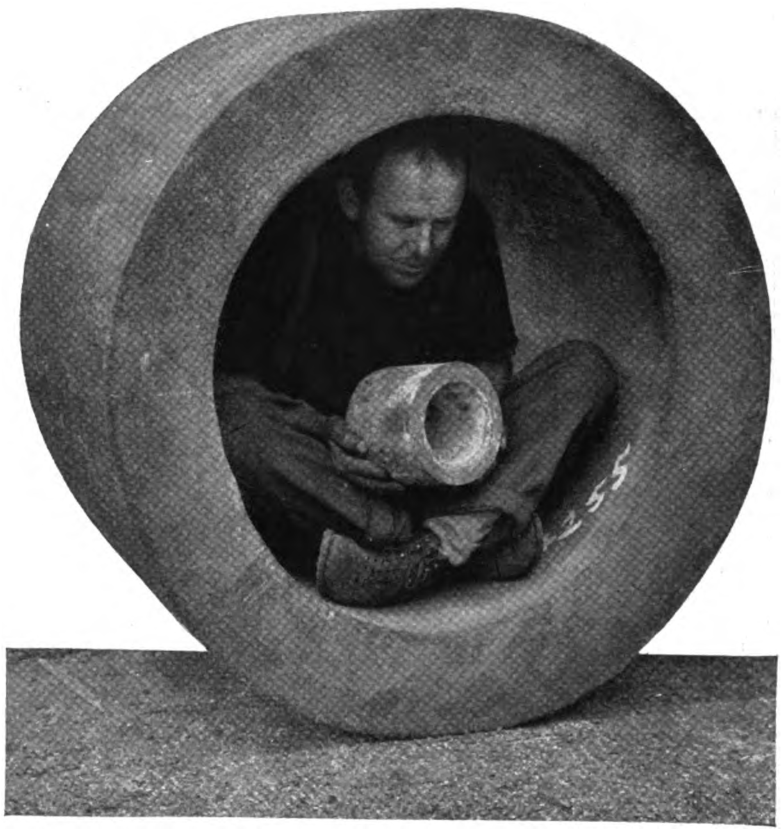
the very best grade of material and workmanship for your forgings by specifying

CAMDEN FORGINGS

You will secure the services of our thoroughly equipped shop and intelligent management by specifying

CAMDEN FORGINGS

You will but profit in communicating with us when in the market for forgings.



OUR PRODUCTS

High and Low Carbon Bars
Press Columns and Rams
Pull Back Cylinders
Water Cylinders
Valve Bodies
Plungers
Weldless Steel Rings
Lathe Spindles, solid and hollow bored
Long Feed Screws
Power Press Crank Shafts
Cam Shafts

Eccentric Shafts
Crusher Shafts
Gear and Pinion Blanks
Locomotive: Side and Main Rods, Crank Pins, Axles, Rod Straps, Guides, Parts of frame both in iron and steel
Hammered Iron Bars for locomotive repairs

Marine Shaft
Marine Connecting and Eccentric Rods
Rolls: Bending, Feed, Straightening, Embossing
Large Wrenches
Saw Arbors
Steam Engine Forgings
Pump Crank Shafts
Pump Connecting Rods

Large Nuts
Turbine Shafts
Mill Shafting
Trolley Car Axles
Electric Motor Axles

Any forging to your print and specifications, smooth forged, rough machined or finished complete in either iron or steel.

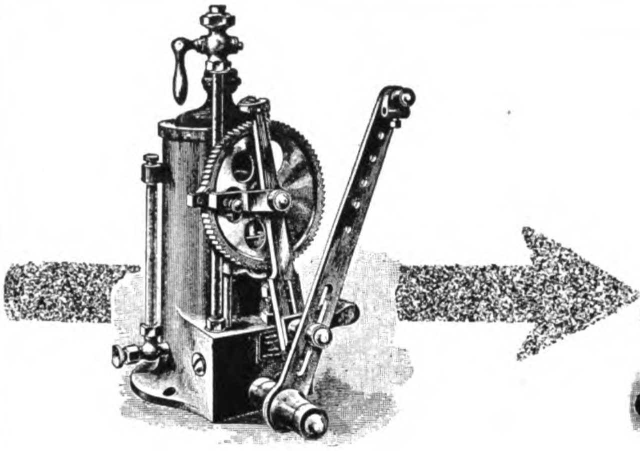
CAMDEN FORGE CO.
8th and Bulson Ave., CAMDEN, N.J.

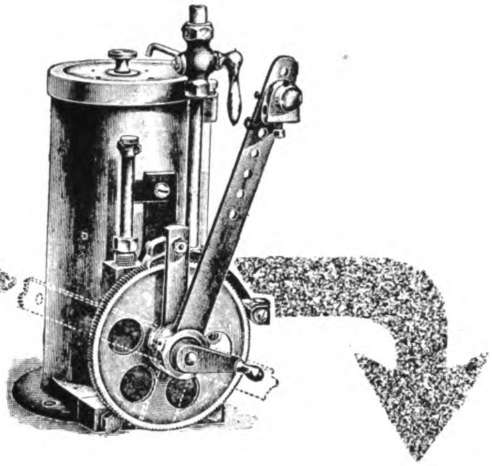
INDUSTRIAL REVIEW

THE CHICAGO PNEUMATIC TOOL Co., Chicago, Ill., fully describe their Fuel Oil Driven Air Compressors in Bulletin 34-K, which contains many fine illustrations of their apparatus both assembled and the constituent parts including cross sectional drawings showing the intimate details of construction. We heartily recommend this booklet to Sibley students taking the courses in machine design and power engineering and especially to those who are interested in compressed air machinery. Bulletin E-45 issued by this same company is descriptive of the Duntley Electric Portable Tools of which they are the manufacturers. This bulletin will be of interest to anyone contemplating the use of portable hoists for any line of work. The Chicago Pneumatic Tool Co. also publish booklets descriptive of electric drill and grinders for either direct or alternating current. Any of their bulletins will be sent upon request.

THE RODNEY HUNT MACHINE Co., Orange, Mass., publishes as their catalogue No. 30 an extensive, well gotten up and profusely illustrated 110 page book describing the complete line of Hunt Water Control Apparatus. The catalogue covers flumes, penstocks and accessories, relief valves, gauges, gates and valves, hoists, stands and trash racks, while the last 20 pages of the book are devoted to useful engineering formulæ and tables covering spur and bevel gears, worms and worm wheels, lumber measurements, useful information on stream measurements, wier tables, velocity of water, and other tables useful for hydraulic work. Sibley students in the machine design and hydraulic courses should find this book particularly valuable, as it is more than a catalogue. It borders on being an engineering treatise. The catalogue will be sent free to anyone on request.

THE LINCOLN ELECTRIC Co., Cleveland, Ohio, manufacturers of induction motors for two or three phase alternating current publishes an extensive booklet of information concerning the details of the manufacture of their various types of induction motors and the many ways in which the motors can be used. This booklet is gotten up in a most pleasing style and is illustrated with an abundance of half tones. Sibley students taking electrical engineering should find it valuable as it contains examples of the best design of induction motors used in the country to-day, while anyone contemplating using electric drive for any kind or type of machinery will find plenty of illustrative examples to guide them in making a proper choice of motor. Enquiries are invited by the engineering department of the Lincoln Electric Co. and their descriptive literature will be sent upon request.



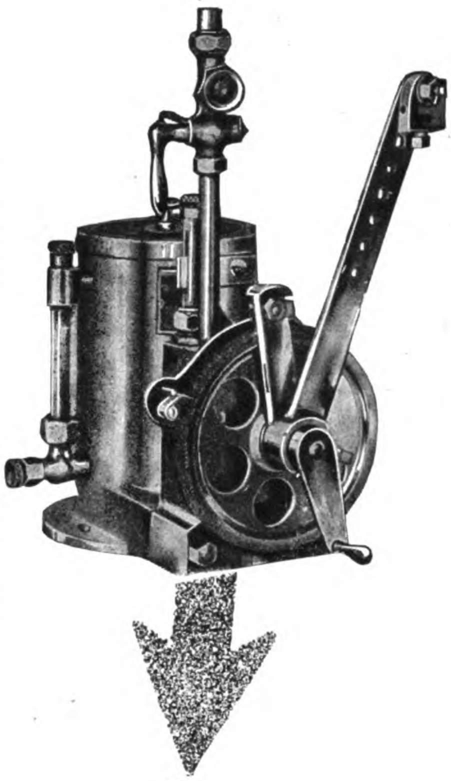


1887

In this year the first Rochester Automatic Lubricator was placed on the market. While greatly improved on since, this model has always shown high mechanical efficiency in construction. Several Rochester Lubricators of this model are still giving perfect service.

1900

The new century introduced the "New Improved Rochester Lubricator." The principal change in this model consisted in separating the pump block and reservoir for convenience in cleaning and repairing. Scores of this model now in daily service after many years' use prove conclusively the sturdiness of its construction.



1887-1916

Trace the development of the

ROCHESTER AUTOMATIC LUBRICATOR

1908

The "Latest Improved Rochester Lubricator" was placed on the market in 1908. This embodied a heavier pump block, an enclosed round cam slide and a change from three way cock to Multiplus Sight Feed.
Today this lubricator is without a "peer" in its type.

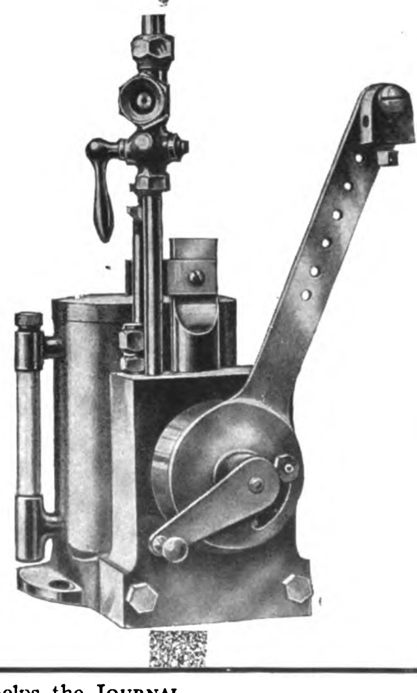
This page shows the various types of Rochester Automatic Lubricators from the first to the New Clutch Drive Model—the king of lubricator perfection.

Read the notes regarding these types and you will see that the Rochester has always kept a step ahead of ordinary lubricator progress.

Send for literature.

1915

Over a year ago we placed the new Rochester Clutch Drive Automatic Lubricator before the public. It is essentially a lubricator designed to meet the most exacting requirements—such as high speed engine work. Besides the clutch drive, a larger stuffing box, automatic gauge glass fixture and some minor features were added. This is the most advanced type of lubricator offered today.



GREENE, TWEED & CO.

109 Duane Street - - New York, N. Y.

English Agents — Jenkins Bros., 95 Queen Victoria Street, London, E. C., England.

PERSONALS

Continued from page 8 Adv. Section

Durand C. Alexander, Jr., '01, is vice-president of the Mason Machine Works, of Taunton, Mass., and general manager of the Quasi Arc Weldtrodes Company, 61 Broadway, New York City.

Bronson H. Smith, x '03, is with Henry R. Kent & Company, 141 Broadway, New York City.

C. G. Spencer, '04, is resident engineer of the Chile Exploration Company at Tocopilla, Chile.

S. H. Woods, '06, is now connected with the International Motor Company, West End Avenue and 64th Street, New York City.

Herman Bartholomay, '07, is a member of the insurance firm known as the Bartholomay-Durling Company, Chicago. He lives at 4878 Sheridan Road.

John A. Ferguson, '07, is secretary of the Merritt-Ferguson Construction Company of New York. His address is 802 West 181st Street.

W. S. Stowell, '07, is an engineer with Westinghouse, Church, Kerr & Company, 37 Wall Street, New York City.

Maurice du Pont Lee, '08, an engineer in the du Pont plant in Wilmington, was married to Miss Geraldine Shaw, daughter of Mrs. Eugene Shaw of 130 East 67th Street, New York City, on December 5, 1916.

H. L. Hupe, '09, is master mechanic for the Standard Furniture Company, Herkimer, N. Y.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI MARCH, 1917 No. 6

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year

Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR MARCH, 1917

Vacation Work for Students

The question of where and how to find suitable summer work is often quite a perplexing problem for the engineering student. It should be given attention long before the arrival of summer, and we feel that a word in regard to this matter will not be out of place.

It is impossible to give the student very much practical work in our colleges due to the obvious lack of time and funds. Yet the sooner the student comes into intimate contact with industrial problems, the sooner will he be able to sense the importance and the relative worth of his theoretical studies. Hence in selecting a position for the summer, the student should in most cases lay more stress on the possible experience to be gained than on the salary earned.

Every year representatives of large engineering concerns come to pick prospective employees from among the senior class. Despite the fact that they come during the first term, they complain that the best men are already signed up. This is not at all surprising. The progressive, wide-awake fellow picks his field and the company with which he intends to work, during his junior year or before and "finds himself" during the summer. If these large concerns want good men the logical thing to do is to offer attractive summer jobs to the juniors. In this way they could weed out the undesirables at less expense and inconvenience than by waiting until after graduation, while the student will return as "a wiser and a better man."

It is interesting to note the steps that have been taken by the National Electric Light Association to assist college students in obtaining positions during the summer months. One of its committees, on Relations with Educational Institutions, is composed of professors from various colleges throughout the country and officials of some of the leading central stations. Its chief function is the promotion of more intimate working relations between the colleges and the electric light and power industry, so as to bring about closer co-operation which will in the end be beneficial to both.

Through its sub-committee on Employment for Undergraduates, this committee assisted in getting summer positions with public utilities for several hundred college men during the past summer. The men were engaged in many different kinds of work and the average time worked was about two months. At the end of the summer a list of questions was sent to the companies that employed students, and also one to the students, regarding the summer work. The

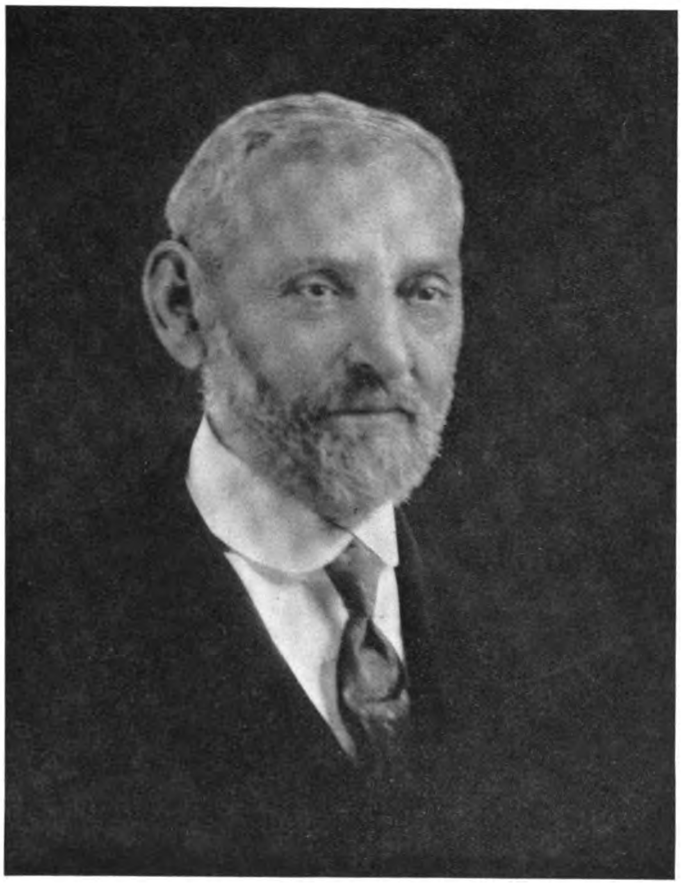
Continued on page 159

GEORGE SYLVANUS MOLER

Professor Moler who retires from active service next June, is a graduate of Sibley College, class of 1875. Since then he has been uninterruptedly on the staff of the department of physics.

While still an undergraduate Mr. Moler acted as lecture assistant to Professor Anthony and for many years these two, devoted teachers and enthusiastic experimenters both of them, constituted the entire staff.

The decade (1875-85) following Mr. Moler's graduation was a remarkable period in the history of applied science. Electricity, for the first time, was becoming a factor in practical life. By means of the dynamo and motor, electric lighting, power and traction were possibilities. The telephone, sprung on an unsuspecting world at the Centennial Exhibition in 1876 was in process of new development. A new profession was born which in the early eighties began to be known as electrical engineering.



When in 1875 the first description of Gramme's new dynamo electric machine reached this country from Paris, Anthony and Moler immediately proceeded to build one. In this endeavor, thanks largely to Mr. Moler's ingenuity and skill as a machinist, they were entirely successful. The new machine was one of the features of the "Centennial" in Philadelphia in the following year.

At the World's Fair in St. Louis, twenty-nine years later, this machine was exhibited as a historic relic and Professor Moler, being one of the constructors, received a medal. It was then in working condition as indeed at the present time after more than forty years, many of them of active service, it still is.

How with the Gramme machine as a source of current many pioneer ventures in practical electricity were made has long since been told in the pages of THE SIBLEY JOURNAL.* Notable among these was the installation of arc lights on the Cornell campus with underground wiring of home construction. These were in regular service years before any of the great cities of the world had electric lighting.

In this as in the subsequent work on the electrolytic manufacture of oxygen and hydrogen, the building of the great tangent galvanometer Professor Moler had his part. The University owes to his inventive genius countless original devices, such as the famous automatic switch which governs the fire pump in Rockefeller Hall.

As a teacher Professor Moler is held in affectionate remembrance by many generations of students. Before the transfer of the work in Electrical Engineering he was in charge of the dynamo laboratory in Franklin Hall and had much to do with the development of the courses for engineering students. Subsequently and with equal success he has taught the important and growing classes in photography and its scientific applications. The photographic laboratory, with its original and unique equipment, is largely of his planning and in the design and construction of other parts of Rockefeller Hall he had an important part.

Professor Moler's published papers deal chiefly with the apparatus which he has invented and constructed and his contributions to science in the form of actual instruments greatly exceed in number the printed accounts which he has found time to prepare. He has expressed the hope and expectation that his retirement from active service will enable him to complete investigations which he has long had in mind but which have been held in abeyance on account of arduous routine duties.

*Professor Anthony at Cornell. SIBLEY JOURNAL, April, 1908.

EARLY HISTORY OF THE DEPARTMENT OF PHYSICS OF CORNELL UNIVERSITY

GEORGE S. MOLER, '75

During the first year of the University the Department of Physics had quarters in Morrill Hall then known as the South Building. During the next four years it was housed in the old Chemical Laboratory, a wooden building which stood just south east of the grove of trees in the Quadrangle. It was then moved to the South end of McGraw Hall where it remained until Franklin Hall was built which was especially designed to accommodate it and the Department of Chemistry.

After the two Departments were settled in Franklin Hall and everything was in good running order the writer was interviewed by a prominent out-of-town Trustee who asked him if he did not think that the Department of Physics was properly housed for all time to come so that attention could be given to providing for the pressing needs of other Departments of the University. I told him that I hoped not and I believed even then that in time the Department of Physics would outgrow those quarters, which has proved to be the case. Professor Anthony asked that Franklin Hall be made only a two story structure, and that was the plan followed till Professor Caldwell requested that additional height be given so that the Department of Chemistry might also occupy part of the building. If this had not been done the Department of Physics could not have stayed there as long as it did.

While the quarters were still in McGraw Hall one plan was to remodel Cascadilla Building for a permanent place and measurements were actually made to see what could be done. Another plan for which drawings were made was to build in between McGraw Hall and Morrill Hall a connecting building to make a place for the laboratories.

"The first Professor of Physics was Eli Whitney Blake who retired after three years of service to accept a professorship in Brown University. He devoted himself while here most especially to electrical investigations, more especially to the electricity developed by the electrical machine. His father was Eli Whitney Blake, the inventor of the Blake stone crusher and his great uncle was Eli Whitney of the cotton gin."* He was succeeded by Rev. John Jackson Brown, a Methodist preacher, who held the position for one year and then went to Syracuse University where he took a similar position. The fifth year Francis Englesby Loomis was the Professor of Physics and he was followed by Professor William Arnold Anthony who was head of the Department for the next fifteen years which brings it down to 1887 from which time Professor Edward Leamington Nichols has been the head of the Department of Physics.

Until the coming of Professor Anthony all instruction was given by one man without any outside assistance. Later Madison Monroe Garver, who is now Professor of Physics at State College, Pa., assisted him for about two years as an undergraduate but he did not do any teaching. In 1875 the writer was appointed to be an Instructor in Physics and he with Professor Anthony taught all the classes for the next eleven years when an additional instructor was appointed to the Department.

Before the Gramme dynamo was built by Professor Anthony and the writer, (which by the way was the first dynamo to be built in America), the only method of getting an electric current to run an arc light for lectures on the properties of light, was by setting up a Grove battery made up of platinum and zinc, having strong nitric acid inside its porous cup and dilute sulphuric acid in the outer jar. This combination could not be kept even over night so it had to be set up freshly whenever it was needed. The setting up took about two hours and a half, and three-quarters of an hour was necessary to take it down and wash up all of the parts. On account of the time, trouble, and discomfort of setting up the battery with its fuming nitric acid, the making of a dynamo which promised to do away with the battery forever was entered into with a hearty good will.

At first the dynamo was run by means of a Brayton petroleum engine and was set up in a basement-room in Morrill Hall while an electrical laboratory was arranged there with it. By means of that engine, only short runs could be made and so the dynamo could not be used for lighting purposes. But one of the students doing special work in Physics begged Professor Anthony to try running a light out of doors West of Morrill Hall where it could shine down town, for he was sure it would light up the valley brilliantly. To please him we borrowed a locomotive headlight, put an arc light in it and directed the beam of light as a sort of searchlight down at the town. We were told afterwards by a man who was on a street down town at the time that he could see the nail heads across the street in the siding of one of the churches.

Up to this time all of the oxygen and hydrogen used by the Department of Physics were made by chemical means which was not a very convenient way of getting them; so the dynamo was moved over to Sibley and was belted to the water power that drove the shops while a line was run over to McGraw Hall where the lecture room of Physics was then situated. The Sibley power at that time was not very steady on account of leaves and corncobs interferring with the supply of water to the wheel so we were able to get only a fluctuating voltage at best. We determined, however, to test it out for the purpose of making our gases electrolytically. A decomposing cell for testing purposes was set up on the lecture table and the gases were collected in two one-quart jars set in water. After the jars were filled Professor Anthony lighted a splinter and pulling out the stopper in the top of one of the jars said now this is oxygen and the spark on the splinter will glow and as he tried it there was a terrific explosion right between us but fortunately the flying glass did not hit either of us. We found, in looking for

*Quoted from Andrew D. White.

the cause of this mixture of gases that exploded, that the power had slowed down until the decomposing cell acting like a storage battery had reversed the polarity of the dynamo, which was a series one, then when the power speeded up the polarity of the cell was reversed and so mixed gases were produced.

At one time three boys who were taking laboratory work in Physics that term, one of whom became a prominent Professor and another who was later a prominent Trustee of Cornell University, brought a live mouse in a cigar box to the laboratory and asked permission of Professor Anthony to electrocute it by means of a spark from the Holtz machine. It took only one spark to painlessly end the existence of the little animal and then they went away. Each soon presented a written report on "The electrical demise of a mouse."

A large number of pieces of apparatus have been designed for the use of the Department and have been built by the mechanician employed, but perhaps the most note-worthy piece was the great Tangent Galvanometer which was constructed in 1885-6. Professor Anthony was a member of the Testing Committee at the Philadelphia Exhibition in 1884 and because no ammeters were available at that time, the committee constructed a temporary Tangent Galvanometer using a one-inch rod of copper and bending it into a circle two meters in diameter. This ring was brought to Ithaca and three other rings of suitable sizes were made to go with it and with the needle and other proper appliances the whole was assembled into what was known as the great Tangent Galvanometer, perhaps the largest instrument of that pattern that was ever built. It was necessary to place this instrument out away from all magnetic influences except the earth's field; so on nearly the spot where Rand Hall now stands, a small wooden building called the "Copper House" was erected to contain it. In putting up this structure copper nails, brass and copper fittings and lead window weights were used and even the stove for heating with its pipe were made of brass and copper. This instrument proved to be of great service to the department until modern ammeters were so nearly perfected that its use became unnecessary.

A STUDY OF THE THIN PLATE ORIFICE

By V. R. GAGE*

Second Installment

2. Measuring the Rate of Flow of Air

As in the case of liquids, the most satisfactory hypothesis is the assumption that the total energy of a steadily flowing stream of gas remains constant. It is best to assume that the pipe and restriction are on the same level. With gases the density changes with both the pressure and temperature, requiring that the pressure-volume-temperature relation be used in the formula. The kinetic energy, and also the potential energy, may partially come from, or be transformed into, heat energy. The common assumption is adiabatic flow. By adiabatic is meant no gain or loss of heat AS HEAT. That is; thermal isolation. But heat may be gained or lost by the transformation from or into other forms of energy.

The pressure-volume-temperature relation for an ideal gas is expressed as follows, by the combined laws of Boyle and of Charles, in which P represents absolute pressure, T absolute temperature, and v the volume occupied by unit weight.

$$\frac{P_1 v_1}{T_1} = \frac{P_2 v_2}{T_2} = \text{a constant}$$

The adiabatic relation of these three variables is expressed as follows, γ representing the ratio of the specific heat at constant pressure to the specific heat at constant volume, about 1.4 for air.

$$\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{\gamma-1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

*Asst. Prof. of Experimental Engineering, Cornell University.

The equation showing the equality of total energy at two points of a steadily flowing stream of gas is

$$H_1 + \frac{V_1^2}{2g} + Q'_1 = H_2 + \frac{V_2^2}{2g} \times Q'_2 \quad \text{[Equation 3}$$

in which H denotes pressure head, V the velocity, g the acceleration due to gravity, and Q' the heat energy in proper units.

The following notation will be used.

Q = cubic feet per second
W = pounds per second
P = absolute pressure, lbs. per square foot.
H = pressure, feet of fluid being measured.
g = 32.2
V = velocity, feet per second
v = specific volume, cubic feet per pound.
γ = ratio of specific heats.
δ = density, pounds per cubic foot = $\frac{1}{v}$
F = area, square feet

Subscript 1 refers to upstream section, subscript 2 refers to the contracted area.

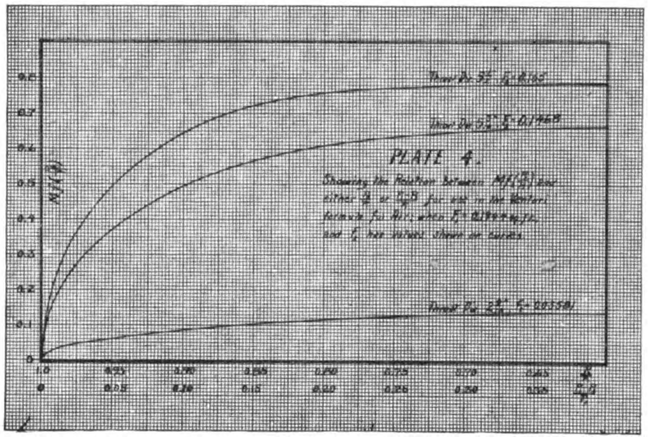
Using equation 3 together with the laws of adiabatic flow, the velocity at the contracted area is

$$V_2 = \left(\frac{P_1^{\frac{1}{2}}}{\delta_1}\right)\left(\frac{2g\gamma}{\gamma-1}\right)^{\frac{1}{2}}\left\{\frac{1-\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}}{1-\left(\frac{F_2}{F_1}\right)^2\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}}}\right\}^{\frac{1}{2}}$$

[Equation 4

Multiplying this by the area at the throat would give

the volume passing the throat. But both pressure and heat have been transformed into kinetic energy at this point, and the volume under the original



conditions at the full section is what is desired. Hence the adiabatic relations in connection with the laws of Boyle and Charles must be used. The resulting formula expressing the quantity flowing through the pipe in unit time is

$$Q = \left(\frac{P_1}{\delta_1}\right)^{\frac{1}{2}} F_2 \left(\frac{2g\gamma}{\gamma - 1}\right)^{\frac{1}{2}} \left(\frac{P_2}{P_1}\right)^{\frac{1}{\gamma}} \left\{ \frac{1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}}{1 - \left(\frac{F_2}{F_1}\right)^2 \left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}}} \right\}^{\frac{1}{2}}$$

[Equation 5

This equation cannot be reduced to a constant times the square root of the pressure differences as can be done with the formula for a liquid. But it can be reduced to two values derived from the data concerning pressure and density times a function of the ratio of pressure. This function may be called the M function of the pressure ratio, and abbreviated to $M f\left(\frac{P_2}{P_1}\right)$ Equation 5 thus becomes

$$Q = \left(\frac{P_1}{\delta_1}\right)^{\frac{1}{2}} \times M f\left(\frac{P_2}{P_1}\right) \qquad \text{[Equation 6}$$

or, for obtaining the weight discharged multiply the volume by the density, and equation 5 becomes

$$W = (P_1\,\delta_1)^{\frac{1}{2}} \times M f\left(\frac{P_2}{P_1}\right)$$

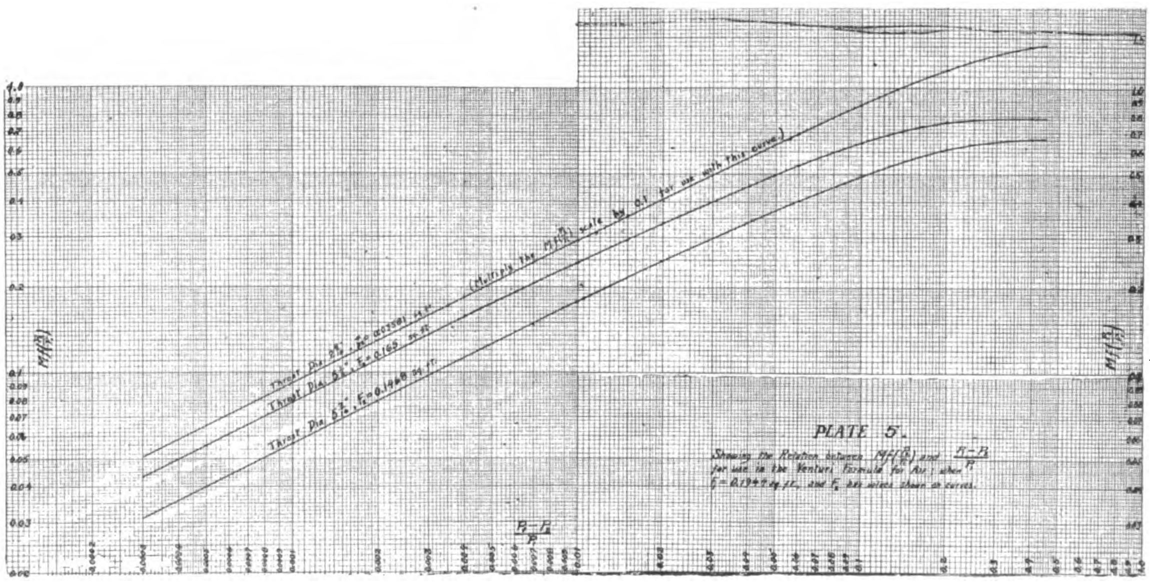
For a complete derivation of this equation see Mr. E. P. Coleman's article in the Transactions of the American Society of Mechanical Engineers, Volume 28, pages 483 et. seq. He there shows how, for any given dimensions of Venturi Meter, the relation of $M f\left(\frac{P_2}{P_1}\right)$ to $\frac{P_2}{P_1}$ may be computed and plotted as a curve, and then in subsequent use, for any observed pressure ratio, the $M f\left(\frac{P_2}{P_1}\right)$ value may be read from this curve. Plate 4 shows the form of this curve as given there.

It would appear better to subtract the pressure ratio from unity, thereby obtaining the pressure difference divided by the original pressure, thus:

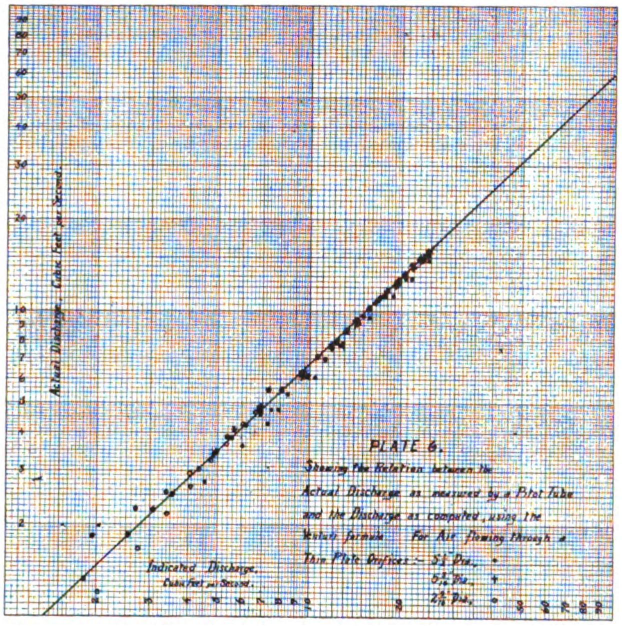
$$1 - \frac{P_2}{P_1} = \frac{P_1 - P_2}{P_1}$$

(The lower scaling on Plate 4 gives this.) By this means, logarithms, in the form of cross section paper on which the distances between the lines are proportional to the logarithms of the numbers shown, may be successfully employed.

The curves on Plate 5 are plotted from same computations as the curves on Plate 4. All values are computed from Equation 5, using throat diameters of $5\frac{1}{2}''$, $5\frac{3}{16}''$, and $2\frac{9}{16}''$ in a pipe nearly 6" in diameter. Note that the numerical value of the ordinate is not the same for the $2\frac{9}{16}''$ diameter as for the other two. For small rates of flow, that is for small pressure differences, these curves approach as a limit a straight line having a slope of ½, and they are so close to this limit for quite a range that the curves cannot be distinguished from the straight line. As the rate of flow increases the curves show a deviation from the straight lines and at the point where $\frac{P_2}{P_1} = 0.527$, or



$\frac{P_1-P_2}{P_1}=0.473$, the curves become horizontal. Beyond this point they are imaginary. The explanation of this lies in the laws of adiabatic flow which prove that



the maximum discharge (for this type of orifice) takes place when

$$\frac{P_2}{P_1}=\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$$

The numerical value of this "critical pressure ratio" for air, and for other gases having γ of the value of 1.4, is 0.527. That is, the actual pressure of the stream of air issuing from this form of orifice can not be less than 0.527 of the pressure upon the orifice, as proved by experiment and theory.

The curves on Plate 5 also show that the greater the reduction in area at the throat, the more nearly the curve is a straight line. That is, the term $\left(\frac{F_2}{F_1}\right)^2$ has less effect upon the curve, which is to be expected from an inspection of Equation 5.

In the region of comparatively small pressure differences this curve may be considered a straight line with a slope of 0.5 The indicated discharge is proportional to the square root of the pressure difference divided by the upstream pressure. When the original pressure remains nearly constant the indicated discharge varies directly with the square root of the pressure difference. Therefore the adiabatic changes are negligible in this range. When this is true, the formula developed for fluids of constant density may be applied. This formula may be expressed in the several ways shown below:

$$Q = F_2\left(\frac{2g(H_1-H_2)}{1-\left(\frac{F_2}{F_1}\right)^2}\right)^{\frac{1}{2}} \qquad \text{[Equation 2}$$

or

$$Q = F_2\left[\frac{2g}{1-\left(\frac{F_2}{F_1}\right)^2}\right]^{\frac{1}{2}}\left[\frac{P_1-P_2}{\delta}\right]^{\frac{1}{2}} \qquad \text{Equation 7}$$

$$Q = M\left(\frac{P_1-P_2}{\delta}\right)^{\frac{1}{2}} \text{ or } W = M\left[\delta(P_1-P_2)\right]^{\frac{1}{2}}$$

In the formula as given, the density must be computed from the actual pressure and temperature conditions existing. The formula can be changed to include the laws of Boyle and Charles and the necessary constants, thus eliminating the density.

In designing a meter to measure quantities of gas within the limits where Equation 7 may be used, the reduction of area should be neither too great nor too small. For with a large reduction in area the density change is relatively greater with increase of rate of flow although Equation 5 is more nearly approximated by Equation 7, as is shown on Plate 6. For small reductions of area the manometers must magnify the readings to a larger extent.

For the purpose of learning concerning the coefficient of the Sharp Edged Thin Plate Orifice placed in a Pipe, and also to study the laws governing the same, a series of experiments was made. Described briefly; the air from a 24″ double inlet Forge Type Blower was discharged through a pipe in which was located a modified Pitot Tube for measuring the actual discharge, and a Thin Plate Orifice very similar in construction to Figure 2, the holes for measuring the pressure were drilled through the flanges. Three sizes of orifice were used.

The blower outlet was about 5″ diameter, entering the 6″ pipe. The pipe joints were flush, especially constructed not to disturb the flow. The impact tube of the Pitot was placed about nine feet from the blower, the pressure openings of the Pitot about thirteen feet from the blower, and the Thin Plate Orifice was located about sixteen feet from the blower, having about five feet of pipe beyond the orifice.

The modified Pitot Tube was really two separate devices. The Impact Tube; a small brass tube 1/8″ external diameter and 1¾″ long with the open end facing the stream of air beveled to a knife edge. By means of this tube a traverse across the pipe was made, using the "ten point method" for obtaining the average velocity. [The area of the pipe was divided into ten equal and concentric areas, one circle and nine rings. The impact tube was placed at five points on each side of the center, on the boundary between the circle and the first ring, between the second and third rings, and so on.] The pressure head was obtained from four holes (drilled with a No. 60 drill) equally spaced around the circumference of the pipe, and each of these connected to a common header. These holes were absolutely smooth and flush on the inside of the pipe, and were so small that no appreciable eddy currents could form in the openings.

As to the reasons for arranging the Pitot tube in this manner. A "standard" Taylor Pitot Tube caused too much disturbance of the stream lines of the air, so that the pressure head indications were incorrect. Then the smaller impact tube was placed so that the open end was in the same plane as the four pressure

openings. When the impact tube was entirely across the pipe the pressure head was increased due to the reduction of free area. So it was found necessary to separate the impact and pressure head devices, as described. The common assumption is that the pressure head is constant across the pipe. This is not strictly true, but the error was much less in assuming it true, than in attempting to measure the pressure head at the various points of the traverse.

All the manometers used were multiplying except the upstream pressure on the orifice, which was an ordinary glass U tube. These multiplying manometers were made from large glass bottles with bottom outlets connected by rubber tubing to glass tubes, slanted so that one inch vertically measured five inches along the glass tube. All heads were measured in inches of water, and then changed into the proper units as required.

The impact tube was connected to the bottle of one manometer, and the pressure openings to the end of the slanting tube. Thus the pressure head acted on both surfaces of the water and cancelled out, the reading was the velocity head. The pressure openings were also connected to another manometer bottle, and the end of the tube was left open, the reading was the pressure head above atmospheric pressure.

The three orifices were of sheet tin, and were circles, cut out, of $5\frac{1}{2}''$, $5\frac{3}{16}''$, and $2\frac{9}{16}''$ diameter. Each of these orifices, one at a time, was placed concentric with the pipe, between the flanges. The pressure on each side of the plate orifice was obtained from openings flush in the wall of the pipe, located about $\frac{3}{16}''$ from the plate, and of diameter about 5-32″. The difference of pressure between the upstream and the downstream sides of the orifice was read on the third multiplying manometer. In addition, the upstream pressure was read upon a U tube.

Methods of Computation

The actual discharge, computed from Pitot Tube. Cubic feet per second equals area of pipe multiplied by average velocity in pipe. The observations were the velocity head at ten points in pipe, every point representing an equal area. The average velocity equals the square root of 2g times the average of the square roots of the velocity heads, in feet of air. To obtain this latter term, extract square root of each reading on one traverse, in inches of water, and average the square roots. For the existing temperature and pressure find the height, in feet, of a column of air which would balance a column of water one inch high. (Balance the pressures exerted by these columns. Extract its square root, multiply by the average of square roots of the ten readings, this gives the average of the square roots of the velocity heads in feet of air.

The indicated discharge, computed for the Thin Plate Orifice, by use of equation 5 in the following manner. Convert the observed pressure difference in inches of water to pounds per square inch. Convert both the barometric pressure and the pressure in the pipe to pound per square inch, and add together. Divide this sum (the absolute pressure) into the pressure difference, using value to enter Plate 5, and at intersection with curve of orifice in use, read $Mf\left(\frac{P_2}{P_1}\right)$. Compute density for this absolute pressure, and with these values substitute in Equation 6.

The coefficient of the Thin Plate Orifice is the actual discharge as obtained from the Pitot Tube divided by

	←Pitot Tube→			←Thin Plate Orifice→ 5½″ Dia.				
Blower R. P. M.	Press. Hd. " water	Av. $\sqrt{\text{vel. hd.}}$ " water	Q = Cu. ft. air per sec. Actual	P_1 " water (5½″ Orifice)	P_1-P_2 " water (5½″ Orifice)	Q = Indicated Cu. ft. per sec.	Coefficient	
900		.359	4.73			7.94	.595	Oct. 13, 1914.
1200		.461	6.08			10.4	.585	Barometer 29.20 inches Hg.
1500		.593	7.81			12.96	.603	Room temperature 73° F.
1800		.726	9.56			15.86	.604	End full open.
2100		.842	11.10			18.81	.591	
2400		.968	12.75			21.60	.590	
2700		1.105	14.56			24.82	.587	
900	.48	.209	2.76	.5	.045	4.53	.609	Nov. 3, 1914.
1200	.89	.273	3.61	.88	.08	6.02	.600	Barometer 29.17 inches Hg.
1500	1.45	.346	4.57	1.45	.12	7.33	.623	Room temperature 75° F.
1800	2.11	.405	5.35	2.10	.16	8.46	.632	End open $3\frac{11}{16}''$ dia.
2100	2.95	.465	6.14	2.91	.22	9.88	.622	
2400	3.83	.528	6.97	3.75	.29	11.32	.615	
2700	4.9	.590	7.78	4.75	.37	12.77	.610	
900	.05	.359	4.77	.07	.14	7.55	.632	Oct. 28, 1914.
1200	.09	.461	6.12	.11	.24	9.76	.627	Barometer 29.20 inches Hg.
1500	.13	.593	7.9	.17	.38	12.3	.640	Room temperature 73° F.
1800	.18	.726	9.65	.20	.57	15.0	.643	End full open.
2100	.24	.842	11.17	.34	.80	17.7	.632	
2400	.31	.968	12.8	.45	1.07	20.4	.629	
2700	.38	1.105	14.7	.58	1.39	23.3	.632	

	←Pitot Tube→			←Thin Plate Orifice→ $5\frac{3}{16}''$ Diam.				
Blower R. P. M.	Press. Hd. " Water	Av. $\sqrt{\text{vel. Hd.}}$ " Water	Cu. ft. per Sec., Q Actual	P_1 " Water	P_1-P_2 " Water	Q = Indicated cu. ft. per sec.	Coefficient	
750	.055	.315	4.10	.08	.14	5.63	.729	Nov. 17, 1914
900	.08	.370	4.83	.10	.21	6.88	.703	Barometer 29.25 inches Hg.
1050	.105	.427	5.57	.15	.30	7.36	.758	Room temperature 63°F.
1050	.105	.427	5.57	.15	.29	8.06	.692	End full open
1200	.13	.484	6.31	.19	.39	9.43	.670	
1350	.17	.547	7.13	.25	.495	10.56	.665	
1500	.21	.597	7.78	.29	.62	11.81	.658	
1650	.25	.657	8.56	.35	.78	13.19	.649	
1800	.30	.710	9.25	.40	.90	14.18	.652	
1950	.35	.782	10.18	.48	1.08	15.52	.655	
2100	.40	.848	11.05	.55	1.28	16.85	.655	
2250	.47	.898	11.70	.65	1.44	17.87	.655	
2400	.52	.956	12.46	.70	1.665	19.27	.647	
2550	.58	1.014	13.21	.82	1.88	20.53	.643	
2700	.66	1.083	14.11	.95	2.115	21.70	.650	
2850	.74	1.137	14.82	1.05	2.375	23.02	.643	
3000	.82	1.197	15.60	1.15	2.67	24.38	.640	
900	.09	.362	4.63	.10	.21	6.90	.672	Nov. 24, 1914.
1200	.14	.480	6.14	.20	.42	9.53	.643	Barometer 29.50 inches Hg.
1500	.22	.602	7.70	.30	.66	11.82	.652	Room temperature 48°F.
1800	.31	.724	9.26	.43	.97	14.30	.647	End full open.
2100	.42	.845	10.81	.60	1.33	16.47	.657	
2400	.54	.963	12.31	.75	1.75	19.32	.638	
2700	.69	1.095	14.00	.97	2.20	21.70	.645	
3000	.85	1.204	15.39	1.25	2.75	24.17	.637	

Blower R. P. M.	Pitot Tube: Press. Hd. " Water	Pitot Tube: Av. √ vel. hd. " water	Pitot Tube: Cu.ft. per Sec. Actual Q	Thin Plate Orifice 2 1/16" Dia.: P_1 " Water	Thin Plate Orifice 2 1/16" Dia.: P_1-P_2 " water	Thin Plate Orifice 2 1/16" Dia.: Q = Indicated Cu. ft. per sec.	Thin Plate Orifice 2 1/16" Dia.: Coefficient	
900	.48	.14	1.85	.5	.62	1.94	.953	Nov. 3. 1914.
1200	.89	.17	2.25	.88	1.20	2.70	.833	Barometer 29.17 inches Hg.
1500	1.45	.192	2.54	1.45	1.91	3.40	.747	Room temperature 76° F.
1800	2.11	.225	2.97	2.10	2.71	4.09	.728	End full open.
2100	2.95	.258	3.41	2.91	3.76	4.80	.710	
2400	3.83	.291	3.85	3.75	4.80	5.38	.716	
2700	4.90	.322	4.26	4.75	6.10	6.03	.706	
900	.50	I.	1.32	.56	.54	1.82	.723	Nov. 3. 1914.
1200	.92	.14	1.85	.92	1.05	2.53	.731	Barometer 29.17 inches Hg.
1500	1.46	.17	2.25	1.40	1.56	3.09	.729	Room temperature 77° F.
1800	2.08	.19	2.51	2.08	2.26	3.55	.706	End open 3 11/16" dia.
2100	2.90	.23	3.04	2.88	3.08	4.36	.697	
2400	3.86	.26	3.44	3.80	3.98	4.90	.702	
2700	4.80	.29	3.84	4.80	5.00	5.5	.699	
900	.56	.094	1.2	.55	.72	2.02	.595	Nov. 24. 1914.
1200	.99	.130	1.66	.97	1.29	2.73	.610	Barometer 29.50 inches Hg.
1500	1.56	.171	2.18	1.60	2.01	3.40	.642	Room temperature 47° F.
1800	2.25	.210	2.68	2.25	2.87	4.08	.658	End full open.
2100	3.12	.251	3.22	3.12	3.95	4.75	.678	
2400	4.10	.290	3.68	4.05	5.12	5.38	.685	
2700	5.20	.330	4.21	5.15	6.50	6.05	.695	
3000	66.3	3.65	4.68	6.35	7.96	6.63	.705	

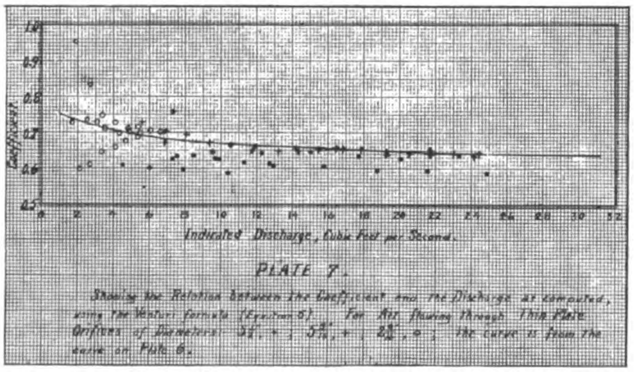
the indicated discharge as computed for the Thin Plate Orifice.

Data and Results

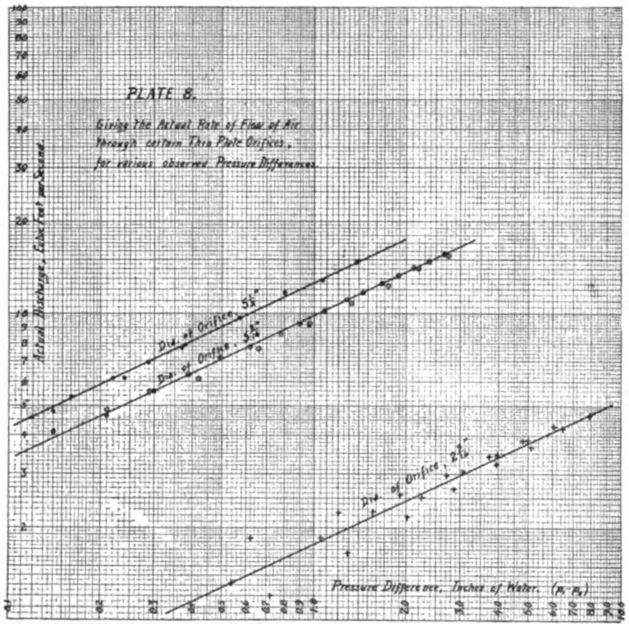
A brief tabulation of the most essential data and results is included herewith.

Curves

Plate 6 shows the relation between the actual and the indicated discharge, on logarithmic scaling. Apparently the points from all the orifices fall upon the same straight line, having a slope of about 1.07 which is twice the value of the "critical pressure ratio." With the smaller quantities and smaller pressure differences the errors of observation are relatively greater, so the points are more scattered and are of less certainty. The data was purposely taken under widely varying temperatures and barometric pressures, undoubtedly these conditions, if changed enough, would form distinct lines, parallel to the curve shown. These lines might possibly be forced to have a slope of unity, especially with the 5½", largest orifice. It is also possible, that with the use of extreme accuracy, the curves for various ratios of areas might be found



to have different slopes. The fact remains, that under the conditions of this test, ordinary accuracy, one straight line shows the relation between actual



and indicated discharge for various sizes of orifices, under varying temperatures and pressures.

By reading the values from this curve (Plate 6) and thus computing the coefficients, the smooth curve on Plate 7 was obtained. Apparently the coefficient is unity at no flow, and has the value of the critical pressure ratio (0.527) as an asymptote. The points on Plate 7 show the relation between the coefficients, as computed from the actual data, and the indicated discharge.

Thus far in the study of these tests some peculiar relations are apparently indicated. So far no satisfactory explanation has been found. It is possible they are due to accident.

Concerning the Easier Approximate Methods

The statement was previously made that the adiabatic changes were negligible under some conditions. In order to see how correct this is with these tests, Plate 8 was plotted to show the relation between the actual discharge and the pressure difference. With logarithmic scaling each orifice plots as a straight line, and all are parallel, having slopes of about 0.47. (This is another coincidence, being one minus the critical pressure ratio, and also one-third of γ). The slope should be 0.5, but a variable coefficient will change it. If a Venturi was used undoubtedly the slope would be much nearer 0.5. It is probable that these curves are of the same general form as the lower portions of the curves on Plate 5. Even if they did continue as straight lines they would come to an abrupt end when the pressure ratio became 0.527, for the blower is incapable of increasing the pressure to any great extent. If, however, the upstream pressure could be increased indefinitely, then the curves

Continued on page 153

TRAINING MEN IN THE ELECTRICAL INDUSTRY

C. S. COLER, '11

EDITOR'S NOTE:—Mr. Coler graduated from Sibley College in 1911. He is at present manager of the Casino Technical Night School which is conducted under the auspices of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. He is also secretary of the committee on "Occupations and Rates" for the Company.

Education is training for life—a means to an end· Life consists primarily of work and recreation. When an individual comes into Industry untrained, or trained for a life which he is not going to live, his power factor is low. To raise it he must be trained in the industry.

The necessity for this training and its value is made more apparent when it is considered that 50 per cent of those who start in our public schools drop out before completing six years and 86 per cent before entering high school. Also, that 61 per cent of the 14 per cent who enter high school drop out before completing the course.*

Industry is undergoing continual and rapid changes. Materials, methods of manufacture, machinery and money are being investigated, studied and applied in more economical ways. In many instances steel has replaced cast iron and wood; forgings have replaced castings; high speed tools and machinery have replaced those of lower speed and the corporation has taken the place of the small concern.

The man in industry is receiving more attention than ever before. Occupations and men are being studied with the view of placing each man on the work which he is best fitted to do. Wasted effort is being eliminated so that each employe can earn more for the same expenditure of energy. Working conditions are being improved and unsafe conditions removed. Such changes which effect economies in production without placing the burden on the employe are economically sound—employer, employe and consumer alike benefiting therefrom.

Industrial education, if of the right kind, is economically sound. It increases the earning capacity of the individual by enabling him to perform a more valuable service in the industry. Higher priced individuals trained for their work will replace the lower priced untrained ones.

Knowledge, skill, and a trained mind are demanded in various proportions by each kind of work in the Electrical industry. With a trained mind the knowledge and skill necessary for any given kind of work should be more readily acquired. To allow an individual with natural ability to remain permanently on an inferior job because of lack of training is as poor a principle in modern industry as to use untempered drills. To educate or train any individual for work which he is inherently unfitted for is like trying to temper cast iron.

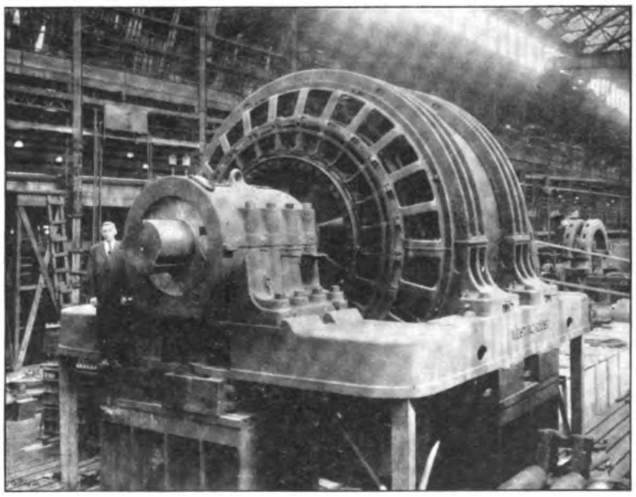
The following description will show what is being done by one of the large Electrical manufacturing companies to train men and women for their work and to place them on the work for which they are best suited.

The jobs range from office boy to the highest executive positions in the manufacturing, engineering, sales or construction departments. The men trained range from youngsters fourteen years old, who have very often completed less than eight years of grammar school work, to technical graduates.

The office boy has an opportunity, while making the best of the job he is on, to train in the continuation school for his next job. He may then take up a tracing course to prepare him for work in the drafting office or an apprenticeship course to prepare him for work on a trade, such as pattern maker, foundryman, machinist, tool maker, or electrician. Individual records of characteristics and performance are kept and used as a basis for promotions.

Besides obtaining the knowledge which is necessary on these Trades and acquiring skill, the apprentice is given class room work to insure that he is making the proper mental progress while he is acquiring experience in the shop.

For those who have entered the industry as regular employes, optional courses are given in the Casino Technical Night School to prepare them for more advanced work as inspectors, testers, rate men, shop executives, correspondents, engineers or salesmen according to their aptitude.



"A Product of Intellect and Skill"
Reversing BloomingMill Motor 1500 H.P.—Weight of Rotating Part about100 tons—Total weight over 250 tons—Time for complete reversal two seconds—Diameter of shaft over two feet.

*Introductory Survey, Department of the Interior, Bureau of Education. Vol. 2, 1914.

The engineering department of the Night School offers a four years' training in engineering subjects—mathematics through trigonometry, pattern making, drawing, foundry, machine shop, physics, chemistry, metallurgy, electricity, steam, mechanics, English and letter writing.

For those who are not prepared to enter the engineering department of the school two courses are provided; a two year preparatory course in English, spelling, arithmetic, drawing and commercial geography, and a course for foreign born men in writing, speaking and understanding English.

Courses for women are provided in sewing, cooking, music, typewriting, shorthand, English, spelling, comptometer operation and arithmetic.

These courses are taught by men and women holding responsible positions in the industry and thoroughly acquainted with their subjects from an industrial point of view. The training is general in nature, placing primary accent on mental development. It consists principally of various kinds of problems the solution of which necessitates effort on the part of the student in obtaining data, acquiring and applying methods of analysis and expressing results in usable form.

The school is supported by the industry, the local communities and the students. The students are hard working, very much interested in their development and appreciative of the opportunity offered them for advancement. They learn to work by working and to think by thinking.

The graduates are practically all working, in positions of responsibility. Over a thousand men and women are receiving mental training in the Night School. This combined with the practical experience received on their regular work is fitting them for better positions.

A number of technical graduates are selected each year from the various engineering schools of the country to fill positions which are continually arising with the Company due to the growth of business and changes in personnel. The general plan for graduate students is arranged to round out the students' engineering training by practical experience and to assist him in finding his field of greatest aptitude. Special training under the direction of expert engineers is provided for those who have decided on the kind of engineering work they wish to follow.

In this organization alone some eighteen hundred men and women are trained for more advanced positions in the industry, each year, through educational courses.

A NEW FOREST FIRE LOOKOUT MAP

EMANUEL FRITZ, '08

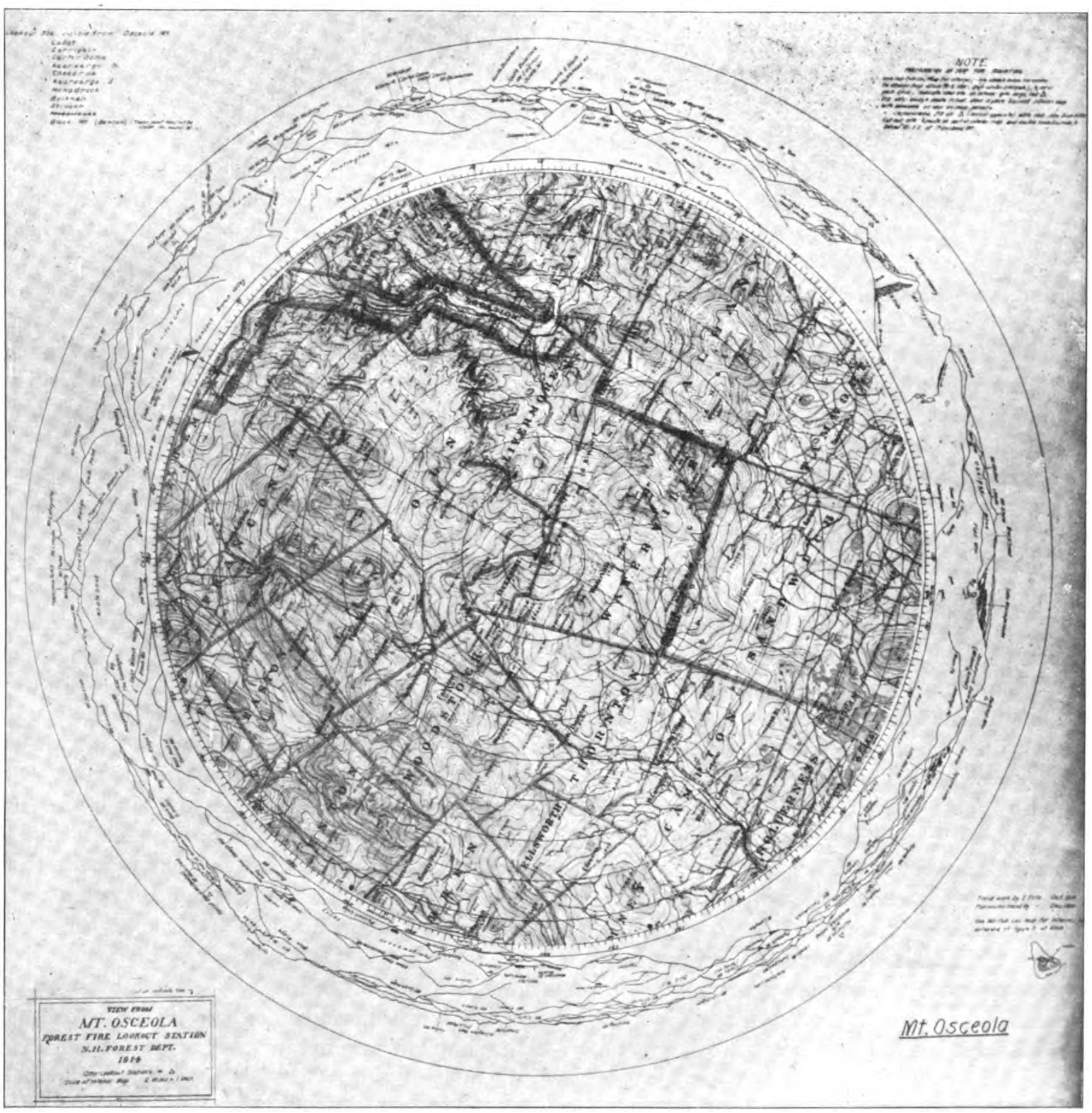
Forest fires to be suppressed cheaply and before they cause much damage must be detected in their incipiency and then located accurately. Forest owners, both public and private, have stationed watchmen or lookout men on many elevated points that command good views of their properties. The owners rely to a very large extent upon these lookout men to protect the resources at stake. The rapidity of detection depends upon the alertness of the lookout men, but the accuracy of location depends upon their knowledge of the country. Lookout men are picked for their alertness and dependability, but it is very difficult to get men who know sufficiently well the large area of wild land surrounding the lookout stations. They usually know parts of their territory fairly well, but to acquaint them with the entire territory each is to cover, they must be supplied with accurate maps. An ordinary base map, showing the country, is valuable, but not every man can make proper use of such a map, because it does not give a picture of the country as it actually appears to the eye from the lookout point. Photographs of the panorama are also excellent aids, but they fall short in that the pictures are flat; i. e., they present the country as lying in the form of a rectangle, whereas the country actually is disposed radially all around the lookout point. To provide a map which makes the country appear on paper just as it looks in any and every direction to the observer on the lookout point, the relief map was developed.

The map is circular, twenty-six inches in diameter, mounted under plate glass on a permanent stand on the lookout point or tower, and oriented accurately with the cardinal points of the compass. It consists of two parts—the base map and the relief. The base map portion covers a circular area on the finished lookout map, twenty inches in diameter, thus leaving a three-inch annular space on the edge, into which is drawn the relief. The base map may be a standard road map, with a scale of one, two or more miles to the inch. If the base map shows the topography of the land surface, so much the better. The center of the base map is the point corresponding to the top of the hill or mountain on which the lookout station is located. From this point as a center, concentric circles are drawn on the map, so spaced that each represents a radial distance of an even mile or number of miles from the lookout station. It is desirable that the base map be shortened a quarter of an inch radially, and that the ¼ inch space thus gained be divided into 360 spaces or degrees, making of this narrow space a protractor circle—useful in methods of triangulation. The base map should be an accurate one, a U. S. Geological Survey map or a commercial road map of proved accuracy. Section lines and political boundaries should be drawn; and

if possible, it is desirable to indicate on the base map special data of interest to the forest fire-fighting work, such as dense stands of timber, old burns, cut over land, points frequented by campers, points of special fire hazard, location of ranchers and miners having telephones, etc.

The relief portion is the special feature of this new lookout map. It is drawn in the three inch space outside the base map, and shows the country surrounding the station just as it appears to the observer's eye, as far as he can see. The reproduction shows the relation of the relief portion to the base map portion of the map. This is not straight, as a photograph would show it, but as the reproduction above shows it is bent into the arc of a complete circle. If the reader imagines himself standing in the center of the map he will be able to tell, by looking at the printed map along any radius, how the country looks in the direction of that radius; and furthermore, because the ridges, valleys, etc., making up the relief have their names printed close to the lines representing them, he will be enabled to learn the name of any feature he is interested in. Besides ridges and valleys, the map also shows, with their names, many other topographic and cultural features such as lakes, streams, cliffs, large houses, camps, and especially railroads if visible.

The map is intended to be used only on the lookout station for which it was made; anywhere else it has only a passing interest. When employed on the station from which it was made, and by one who is a stranger to the surroundings, it performs its greatest service by acquainting him with the names and locations of all features. In reporting a fire the lookout man must know the name of the valley or ridge where the fire was discovered. Suppose a new man not very well acquainted with all of the country visible from his station, discovers smoke rising from behind a ridge, probably fifteen miles or more away. He first studies the location of the fire with his field glasses to make sure if the fire is in the bottom of a valley, or on the near or far side or top of a ridge. Then he stands behind his map-stand in such a position that he, the center of the map, and the fire are in one line. By noting where his line of sight, or the imaginary line between the center of the map and the fire, cuts the relief of his map, he can, by comparing the actual and printed map, find a



point on his printed relief that corresponds to the location of the fire. Since his map is an exact reproduction of the actual feature before him, he reads from the map the name of the ridge or valley that corresponds in shape and position to the one he can see with his field glasses. Having thus learned the name of the ridge, let us say, he follows the radial line toward the center across the base map until he crosses a ridge bearing the name he has in mind. The base map will tell him in what township, near what road or ranch, the fire is actually burning. After reporting his findings to the nearest fire fighting force, his work is done, as far as locating and reporting that fire goes. This method of locating a fire is intended not to replace methods of triangulation, but to supplement them. It is very often the case that only one lookout man can see a smoke, and can therefore get no cross readings from others.

A thin, straight edge built to move in a horizontal plane about the center of the map is used to advantage in making the line of sight appear real on the map. The straight edge is simply turned until it coincides with the line of sight; its edge then serves as a guide to follow the point located on the panorama to and over the base map. A simple alidade is even more effective.

The method of making one of these lookout maps is as simple as it is interesting. Each map must be made from the point where it is to be set up and used later. This makes it necessary for the draftsman, if the lookout point is inaccessible from a village, to camp near his work until the field work on the map is finished. If the weather is good, not only fair but very clear, three or four days are all that is required for the field work for each map, but because of mist, clouds and rain, it may take a week or more. This factor of weather, along with the amount of travel necessary and the rate of salary paid the draftsmen, influences the cost of the map materially. The cost, it may be stated here, will range from fifty to seventy-five dollars per map for field work, office work and mounting. The work is intensely interesting and offers an excellent opportunity for the draftsman to become acquainted with land forms and to interpret with ease the forms he sees. If he makes maps from a number of points, ten to thirty miles apart, he learns how the various features look from different angles and elevations and thus acquires a familiarity with the region that is difficult to acquire in any other line of mapping work.

The equipment for mapping comprises a round plane table twenty-six and one-half inches in diameter, a tripod, a pair of field glasses, a base map of the region, and lastly and most important, a special alidade. The alidade alone requires a description, the rest of the equipment being of standard design, except that the table is round instead of square.

The alidade, which is shown resting on the table in Fig. 2, was especially designed for making round panoramic maps.

It is made entirely of brass and consists of a rectangular main bar or beam, about fourteen inches long, on one end of which is fitted a fixed vertical arm, and on the other end a hinged, inclined arm. Both arms, each about four inches long, are made of seamless brass tubing rectangular in section, one inch wide and three-eighths of an inch thick; the main bar is solid, one inch by three-sixteenths inch thick. All dimensions given are approximate. Sight bars of solid brass, snugly fitting the cavities in the arms, are made to move up or down as desired in the hollow arms by means of rack and pinion arrangements. Each bar can be clamped at any position by means of a small knurled thumb screw. The sliding bar in the vertical fixed arm is known as the rear sight bar, and has near its top a very small peep-hole sight; the bar in the hinged inclined arm is known as the front sight bar and is fitted on its upper edge with a small steel gun sight. On the lower end of this same bar is fixed a small blunt pointed steel pricker which projects through the front wall of the hollow arm about an eighth of an inch. A slot is cut into the front face of the arm to permit the pricker to move up and down with the front sight bar and still project from the arm at any position. This slot is not shown on the photograph, being on the face away from the observer. The inclined hinged arm can not be raised more than 45 degrees from the horizontal, a spring at the joint holding it against a stop in this position. On the under side of the main bar, ten inches from the hinged end, is brazed a long steel pin. This pin acts as a pivot about which the alidade is turned when in use. The plane table has a small hole in its center to receive the pivot of the alidade. For leveling up, a small spirit level is brazed to the upper face of the main bar of the alidade. Two lugs, one under the hinged end and one at the pivot, raise the bar off the table about an eighth of an inch to prevent its entire length from rubbing on the paper. The alidade is used only in drawing the relief, and after a map is finished and set up on its stand for use, the alidade finds no more use on that map.

To make a map, the draftsman first tacks a fresh sheet of drawing paper firmly to his plane table, mounts the table on his tripod, and sets it up over the lookout point. The alidade is then placed on the table—the pivot or pin being pushed through the drawing paper into the hole in the center of the board—and the draftsman proceeds to "level up." Having set his tripod legs firmly and obtained a level table, he proceeds to adjust his alidade to the character of the country he is about to make a map of, so that the alidade will bring the highest and lowest points of the relief within the limits of the three inch annular space. The front sight is raised to its limit and clamped in that position; the alidade is pointed in the direction of the highest point on the sky line, and a sight is taken through the peep-hole in the rear sight bar, across the gun sight in the front bar. If the highest sky-line point is above the line of sight thus formed, the rear sight is kept clamped in this position and must not again be changed while the map is being made; this is important. If parts of the map are drawn with the rear sight at different

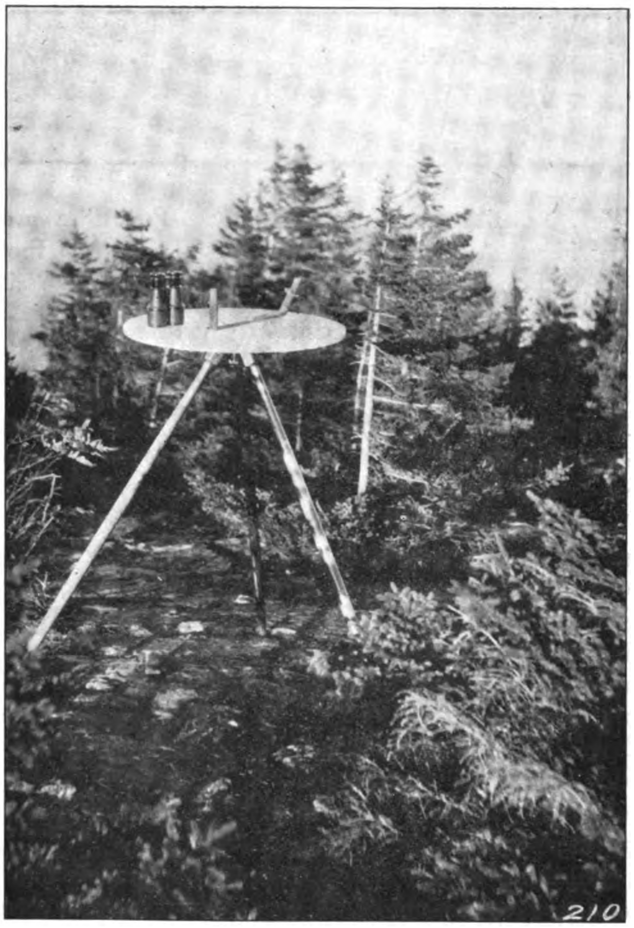


FIG. 2. FIELD OUTFIT.

elevations the relief will be distorted. With the rear sight finally adjusted to his satisfaction, the draftsman begins mapping, starting at any convenient point on any ridge, but following up the ridges in a consistent order. He points the alidade at, say, the lowest point on the nearest ridge, peers through the peep hole at the point, raises or lowers his front bar until the tip of the gun sight cuts the line of vision, clamps the bar, and turns the front arm down on its hinge until the pricker touches and pricks a small mark into the drawing paper. The spring raises the arm again to its forty-five degree point. The draftsman peers through the peep hole again at a point a little to the right or left of the first point on the same ridge, readjusts the front sight and clamps it in the new line of vision, drops the arm on the paper again and causes the second point to be registered on the map. In this way he registers a number of points on the one ridge on his paper. As each point on the ridge is higher or lower than the one preceding it, the gun sight is correspondingly farther from or nearer to the center of the hinge; and since the pricker is attached to the same bar, it will, when the bar is depressed on to the paper for each point, register those points farther from or nearer to the center of the board. When the ridge is finished the draftsman moves the alidade to one side and, with a sharp pencil, joins with a light line all the points pricked on the map.

This completes the field work. All other work thereafter is done in the office, where he traces the field map, draws in the base map, title, etc. The map is then ready for printing; a copy is mounted on a board and covered with heavy plate glass, shipped to the lookout station, and set up there ready for use.

If the relief has been carefully drawn and every feature is lettered with its correct name, it takes but a slight stretch of the imagination to imagine the map to be the actual relief in miniature with the names of the mountains and valleys painted on their sides. The draftsman may not know a name for every hill or valley, but as the finished map is used year after year by different lookoutmen, each of whom may know thoroughly one particular part of the country, the knowledge of such a section can be entered on the map and thus made of record for future new lookoutmen. Eventually the map should contain more information about the surrounding country, as to names of places, etc., than is possessed by any single group of five or six men.

This type of map was originated by Prof. F. B. Knapp of Duxbury, Mass., and was first used by the New Hampshire Forestry Commission on its many fire lookout stations. The Forest Service is also making such maps for use on the National Forests.

FOREST NOTES

During the fiscal year 1916, 705,872 acres of National Forest timberlands were estimated and mapped intensively, and 1,093,006 extensively. In all, 20,815,798 acres have been mapped by intensive methods and 47,291,660 by extensive methods.

The work of classifying and opening to homestead entry such lands in the National Forests as are chiefly valuable for agriculture is progressing rapidly. Already over seventy million acres have been covered by field examinations and the final reports acted upon.

It is estimated that in 1915 about 40,000 forest fires occurred in the United States, which burned over about 5,900,000 acres and caused a damage of approximately $7,000,000.

Revised estimates place the amount of standing merchantable timber in the United States at approximately 2,767 billion board feet. Of this amount 1,464 billion board feet, or 53 per cent. of the total, is in California, Washington, Oregon, Idaho, and Montana.

Continued from page 148

would continue, but the density and other factors would change so much as to eventually force the use of Equation 5. However, these curves show that there is quite a range of quantity which can be fairly accurately measured using Equation 7. If a Venturi Meter is used, the coefficient might be neglected; if a Thin Plate Orifice, the coefficient should be determined; and then it might be used as a constant for rough work. For duplicates of this apparatus, these curves on Plate 8 can be used, reading the actual rate of flow directly from the observed pressure difference in inches of water. For conditions differing from those of these tests, it will be necessary to make special calibration.

ENGINEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Gray, Prof. McDermott, Prof. Diederichs, Prof. Albert, Prof. Wells, Prof. Ellenwood, Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Gage, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Lee, Asst. Prof. Pertsch, H. W. Brown, F. G. Tappan, F. L. Fairbanks, J. F. Wait.

The Sibley Journal will mail the magazines containing the articles absraced to its subscribers at cost price.

Research, W. R. Whitney, director Research Laboratory General Electric Company. February *G. E. Review*.

In speaking of pure research before the Massachusetts Institute of Technology Dr. Whitney regrets the fact that so little research is done now at our universities and engineering schools.

Man develops by trying novelties and taking new paths and there is no physical limit to his development. He never develops by continuous repetition of what he has already learned. In the advance of civilization it is new knowledge which paves the way and progress may be eternal. Most of the foundations of the world's great advances in experimental knowledge have been laid by men who were set apart and supported by the government, or some more or less public institution, where, for very long periods (usually for life), they were encouraged to delve into the unknown.

At irregular times and places men have appeared who seemed to be perpetual interrogation signs. They were never satisfied with what was already known, but they themselves wanted to extend the known with an ardour which was perpetual. They were usually professors. Think of Davy and Faraday in the Royal Institution; of Graham, Ramsay Rayleigh, J. J. Thomson, and Kelvin, in English institutions; of Pasteur in the Sorbonne and Pasteur Institute, of the Curies, of Dumas and Berthelot and others of France; of Helmholtz, Bunsen, Hertz, Wöhler, Hofmann, Ostwald, Haber, and others, in German universities; of Berzelius, vant' Hoff, Mendelejeff, Arrehnius, and a score of men from the universities of other countries. Most of these are men of our time and none of our country. How many such cases can we cite for America? In a few colleges, one or two men are now permitted to carry on a little research work, when it does not interfere with routine teaching. It was not long ago that research, if done at all in some of our colleges, had to be done surreptitiously. At the same time, other countries were paying their best scientists to continue research, and schools of research were being maintained in almost every large German and French city.

We are generally superficial. The interesting lives of a few exceptionally able American inventors have led us to overprize engineering short cuts. We are patenting inventions at the rate of nearly 50,000 a year, but very few Americans are advancing the sciences at all. It is not commonly realized (particularly in America) how generally the world's greatest discoveries were disclosed in their first stages by men who were highly trained and experienced in experimenting. We do not appreciate the fact that usually the long strides in advance are made by careful, painstaking observations of matters not at the time particularly promising or comprehensible to the layman. The foundations of advances are most often made by such men as experimenting science professors, who, with mind skilled in observation and keen in appreciation, have had opportunity to long continue the investigation of some phenomenon of Nature which they observed. Most of the great men are over forty when their most important work is done.

Maturity in age and education has been common, and we must get out of the way of thinking that great advances by original thought and work emanate usually from the young and untrained mind, or are accidents of time and environment.

Prior to the studies of Ampere, no one proposed trying currents in wires acting on magnets as a scheme for communication. The post did that work satisfactorily. No one knew telegraphy as a *want* at all. The use followed after the discovery. The discovery was made by a trained scientist. It was studied by a scientist, and scientists later steered it into useful directions and engineers made it commercial.

So many of the epoch making discoveries have been due to the start given by the purely inquisitive experiments of well trained experts that this way of advancing seems a sure way.

Readers of *Popular Mechanics* some time ago selected by vote the seven wonders of the modern world. The highest votes were received by wireless, the telephone, aeroplane, radium, antiseptics, antitoxins, spectrum analysis, and X-rays. How were these originated? All of them were produced by the identical formula. In the first place, they were not the result of a direct attempt to accomplish what was really attained. The end was not visible when the foundations were laid. The real work was done by thoroughly well trained observers—not by laymen. They were professors in every case. They followed up a lead opened by an observation which was too insignificant to attract the attention of less trained men. The results now formed a large portion of our human inventory, and we ask: Are other such additions

possible? The answer is certainly, Yes, and by the same method. These disclosures are portions of an infinite nature. They seem insignificant until some strenuous and highly studious efforts are expended upon them, and then it slowly becomes apparent that they fit perfectly into our needs. As we could not have foreseen them, so we cannot foresee their followers, but with the extensions of knowledge the possibilities continually increase. The limitations are in us and in our finite vision. We will get ahead in proportion to our training for extending the realms of natural knowledge, and we will grow in proportion to our applications of modern methods used at the advancing boundary between known and unknown. This is the way it has always been done.

F. G. T.

Effect of Barometric Pressure on Temperature Rise of Self-Cooled Transformers. V. M. Montsinger. Engineering department General Electric Co. *G. E. Review*, January.

This paper is a report of tests carried out at Pittsfield (altitude 1,000 feet), Boulder, Colo. (altitude 6,000 feet) and Leadville (altitude 11,000 feet). Tests of temperature rise on three oil-immersed transformers were made. The transformer tanks were (a) with plain surface, (b) with corrugations three inches in depth and (c) with nine inch corrugations. A summary of the results is that: within a limited range of temperature, namely from about 40 deg. to 80 deg. C. loss by radiation varies approximately as the 1.12 power of the temperature rise.

Loss by convection varies as the 1.25 power of the temperature rise. For self-cooled transformers having tanks with irregular contours, the total loss dissipated usually varies as the 1.25 power of the top oil rise. For transformers having smooth surfaces the loss varies close to the 1.15 power of the top oil rise.

Radiation is not affected by barometric pressure.

Convection varies approximately as the 0.5 power of barometric pressure. Or stated in another way, for a constant loss, the temperature rise varies inversely as the 0.4 power of the barometric pressure.

For a constant loss supplied to tanks having different shaped surfaces, the effect of altitude on the temperature rise of top oil is expressed by the formula;

$$\phi_2 = \frac{1.46A}{1 \times 1.3R}$$

in which

ϕ_2 = Increase in temperature rise of top oil* in percentage of rise at lower altitude.

A = Difference in altitude in thousands of feet.

$$R = \frac{\text{Envelope area of tank surface.}}{\text{Developed area of tank surface.}}$$

For transformers having 40 per cent core loss and 60 per cent copper loss (which is increased with an increase in temperature due to higher altitude) the effect is to increase the constant 1.46 in the above formula to 1.6 so that we have

$$\phi = \frac{1.6A}{1 + 1.3R}$$

F. G. T.

*The same connection, i.e., same number of degrees to be added to temperature rise of windings.

Internal Combustion Engine Tests. By W. A. Tookey in *The Engineer*, London, for January 12, 1916.

This article gives the results of tests of different gas and oil engines, and presents a method of comparison of such engines.

It gives curves showing: (1) Variation of piston pressures with mixture strength (by which is meant B. T. U. per cubic foot, supplied.) (2) Thermal efficiency against compression pressure, clearance volume ratio, and total cylinder volume. (3) Thermal efficiency and "Tookey Factor" $\frac{(\text{P m})}{\text{Q r}}$ with varying compression pressures. (4 and 5) Variation of volume ratio upon power output and fuel efficiency—according to mixture strength.

A rather involved wording undoubtedly cloaks some good ideas in this article.

V. R. G.

Orifice Measurement of Air in Large Quantities. By E. G. Harris in the University of Missouri School of Mines Bulletin, Vol. 2, No. 2.

In this paper are given the results of the use of round and rectangular orifices in a four and a half foot square conduit. Calibration is made by means of many small standard orifices in the same conduit. The flow of air at first is not uniform either on entering or on leaving the fan, baffled by means of iron door mats, baffling checked by means of a ribbon in air current. This bulletin finds that the coefficient varies from 0.604 to 0.599 for an orifice thirty inches in diameter, 0.599 to 0.594 for a diameter of twenty-four inches, and 0.597 to 0.592 for one eighteen inches in diameter. For squares orifice it varies from 0.628 to 0.628. Orifices cut in five thirty-seconds of an inch steel plates are held between flanges.

It records difficulties in using any substances except water or mercury in U-tubes on account of vapor pressure, and then glass must be used for both legs on account of surface tension. To avoid oscillations, shot was placed in the U-tube, affording a good damping effect.

V. R. G.

The New York Barge Canal, *Marine Review*, December, 1916.

The big advantage of the New York barge canal, now under construction is the distance it cuts. In the case of materials produced in the region of the Great Lakes and also somewhat to the west of them, as, for instance, the grain from the great belt covering the northern states and southern Canada and also in the case of foreign goods reaching New York from the east, the area influenced by the New York barge canal is extended. A very striking example of the importance

of the barge canal as an essential link in the water route for this vast east and west traffic is shown by considering what happens to a shipment starting from the head of Lake Superior and going to Europe by way of the Mississippi. After it has gone 2,000 miles and reached the mouth of this river it is still 4,500 miles from Liverpool, no nearer its destination than at the beginning, in view of the possible 4,500 mile water route by the Lakes, the barge canal and the Atlantic ocean. G. R. M.

Oil Fuel for the Navy, *Nautical Gazette*, November 23, 1916.

Franklin D. Roosevelt, in a paper read before the annual meeting of the American Mining Congres at Chicago, November 16, stated: "It may be set down as a definite conclusion that the navy cannot and will not revert to coal burning vessels without enormous loss of efficiency; and furthermore the navy will not so revert."

Mr. Roosevelt's paper declared that oil fuel for the navy meant increased speed and cruising radius, control of smoke for smoke screens, reduced fire- room forces by 55 per cent, refueling at sea with an increased efficiency of 25 per cent, ability to sustain maximum speed for long periods of time without clogging furnaces, flexibility in speed and finally, greater safety from submarines, as in modern American ships the fuel oil is disposed of along the bottom to cushion the blow of exploding torpedoes.

The navy burns today in time of peace about 842,000 barrels a year. If battleships are to be replaced, as planned, after 20 years' service, the paper stated, the annual consumption would rise to 10,237,000 barrels in ten years.

Mr. Roosevelt said that the navy was content that every justifiable claim against the reserved lands should be compensated, "but they must cease to remove oil from these lands." There is no question he said that a fair method of adjustment could be found.

G. R. M.

Ball Bearing Assembling and Inspection Methods, *American Machinist*, January 4, 1917.

The methods and gages described in this article give a good idea of the extreme care used in making ball bearings. Few machines are as accurately made, and all the finishing steps are precision processes.

C. W. H.

An editorial from *Aviation and Aeronautical Engineering*, January 1, 1917.

The **Wright-Martin Aircraft Corporation,** capitalized at $5,000,000 owns all the stock of several previously independent airplane companies including the Wright Company. This corporation has notified all companies that it intends to prosecute every infringement of the Wright basic patents and has announced a license agreement under which it is willing to allow other concerns to manufacture. In the January first issue of *Aviation and Aeronautical Engineering*, the Wright-Martin Aircraft Corporation license agreement is printed. This magazine dicusses the situation as follows: "The Curtis Company has also notified constructors that it will expect royalties for the building of seaplanes under its patents. Until this question of basic patents is finally determined the aeronautical industry in this country will be in an unsettled condition. For this reason the sooner the matter is adjusted the better for the owners of the patents, the constructors and the government.

"There are clearly three parties to consider this agreement, the owners of the patents, the possible licensees and the government. The latter has a direct interest as the chief purchaser of airplanes in this country and as the ultimate consumer who will have to pay the royalties. The possible licensees will have to determine the probable validity of the patents, while the owners of the patents will naturally make every effort to exact what in their judgment is a fair royalty.

"It is unfortunate that no advantage was taken by sportsmen or the Government of the generous offer which the Wright Brothers made in 1907 to sell their patents for public use for $100,000. It is another lamentable instance of short-sightedness in dealing with such important inventions. Today conditions have altered. Aeronautics is thought of in large figures. Where thousands were considered extravagant ten years ago, millions are now regarded as inadequate for this increasingly important aim of military and naval service. Large investments have been made in the industrial development of airplanes and accessories. Realizing the ultimate scope of the industry, some of the most influential business men of the country have become interested in the construction of airplanes and aeromotors. The future is to be that of big business.

"The proposed agreements call for licenses and the payment of royalties. Five per cent on the gross business is specified for the use of the Wright patent. The Curtiss royalty has not been announced as yet. There seems to be a general agreement that some payment would clear the situation and enable constructors to operate knowing their position clearly.

"The whole problem then resolves itself into a question as to whether it is preferable to litigate or pay a royalty. As the agreement is not to be retroactive, the volume of business to be considered is from 1916 to 1923. With the five per cent royalty on the gross business, an average minimum of $10,000 a year is asked. This means that a concern will have to do a gross business of $200,000 a year to operate on this percentage as a fixed sum.

"It is probable that these two facts will be more discussed than any others. Whether or not five per cent on the gross business is excessive is a matter of cost accounting which will have to be determined by each constructor. The owners of the patents will have

to determine what protection from unlicensed competition they can guarantee to licensees. The minimum of $10,000 is also a most serious proviso, for many concerns would be deterred from entering the field with this annual payment definitely demanded.

"It is quite probable that the Government will take some part in the settlement of this patent crisis. The Navy particularly has had many patent difficulties to meet and has managed to adjust claims to the satisfaction of patent owners. At the present time, it is merely a matter of adequate compensation. England reached an agreement with the Wrights and it would be unfortunate if the present necessities of this country for aerial equipment were crippled by delays by suits or negotiations of a protracted nature.

"It is clearly a time for all interested to get together and reach a settlement so that the Army and Navy will secure equipment so urgently needed."

M. A. L.

Theory of Enlarged Herringbone Pinions. By E. W. Miller. Januray issue *Machinery*.

The continually increasing use of herringbone gears with involute tooth profiles for large speed reductions at high speeds has lead to the enlargement of the pinions for the purpose of preventing interference. Various formulas of an empirical nature have been used and recommended to determine the proper amount of enlargement for any given number of teeth on the pinion. Mr. Miller derives a rational formula giving the exact amount of enlargement necessary to eliminate the interference and at the same time to increase the pressure angle by the least possible amount. That it is important to keep this increase in the pressure angle small he shows by demonstrating that the angle has already been considerably increased owing to the effect of the helix angle at which the teeth are cut. This effect makes it desirable to keep the helix angle only sufficiently great to maintain tooth contact on the line of centers.

The enlargement of the pinion may be compensated for and the center distance maintained by reducing the diameter of the gear but this is at the expense of an unequal distribution of the tooth action between recess and approach and a consequent concentration of the sliding action and wear, which destroys the smooth, quiet action of the gearing. Mr. Miller believes it better, wherever feasible, to enlarge the gear in the same ratio as the pinion, thereby slightly increasing the center distance and pressure angle but securing a fairly equal distribution of wear.

L. D. H.

Electric Seam Welding. By Douglas T. Hamilton. *Machinery* for January 1917.

The art of seam-welding is a more recent development than that of butt or spot-welding, but has come to be of great importance in the manufacture of utensils such as coffee pots, pails, pans, etc., which are coated with enamel. When welded by this process, it is impossible to detect the joint after the enamel has been applied and baked. The process is commercial, applicable to such materials as pickled mild steel, tin, terne plate and sheet brass. Zinc, aluminum and copper have also been welded, but with some difficulty.

The edges of the piece to be welded are so formed as to localize the contact between them and, therefore, the passage of the heating current. The electrode contacts are made as near as possible to the seam and pressure applied when the proper temperature is reached. This pressure not only completes the weld but leaves the seam flat and smooth. On work of any considerable length the electrodes are in the form of two sets of copper rolls between which the material is passed by means of a power drive. The current enters by one set and leaves by the other and the finishing pressure is delivered by the latter set.

A machine of this kind has been developed which will butt-weld the skelp from which steel pipe is made at a speed equal to that at which it is delivered from the skelp-rolling mill. It has two sets of forming rolls which bend the edges of the skelp together to form a tube and several sets of copper rolls which constitute the electrodes. In this manner a large part of the rolling heat is still in the skelp and it is necessary to increase the temperature but five hundred to five hundred and fifty degrees Fahrenheit in order to make the weld. Continuous pieces of tubing, sixty feet in length, have been electrically heated and welded in from nine to ten seconds. This method is at present limited to tubing two inches in diameter with walls one-eighth of an inch in thickness.

L. D. H.

Modern Friction Surfaces. By J. Oswald in a paper read before the West Scotland Branch of the Association of Mining Electrical Engineers, reprinted in the *Mechanical World* for December 12, 1916.

Efficiency of belts, brakes, clutches, etc., depend upon the co-efficient of friction. The holding power of wood falls away when overheated. Cotton fabric is first treated to render it non-inflammable, and then impregnated with high melting point ingredients. Clutch linings on London motor busses average thirty thousand miles. Cotton fabric has a co-efficient of friction of 0.5 to 0.7. It is higher and can absorb more energy than asbestos fabric. Best results are obtained when it is worn to a dark polish. The temperature limit is four hundred degrees Fahrenheit. Asbestos fabric has a practically constant co-efficient equal to 0.3.

Metal brakes used on railways and subways generate three-fourths of a ton of metal dust per mile per month (New York subway). Such dust caused electrical troubles, formed highly inflamable mixture with oil, and caused fires in Paris and London. Paris, London and Glasgow subways now use cotton, and report no fires since adoption. This also eliminates flat wheels, rail corrugation and considerable tire wear. The use of fabric lined clutches permits the starting of electric motors to be done at no load.

V. R. G.

Vibration in Textile-Mill Buildings. By G. H. Perkins. *Journal A. S. M. E.*, February, 1917.

The author first states the nature of vibration in textile-mill floors and then discusses the following principal causes of such vibrations: Unbalanced machines, inherent weakness of structure, poor soil conditions and sympathetic vibrations originating outside the building.

He then takes up the study of vibration records obtained by a special instrument resembling the seismograph. His experience with this machine makes him declare that "In all cases any movement estimated by the senses was far greater than actually recorded. This bears out the fact that even small and harmless vibrations are often responsible for apprehension on the part of the operatives."

He then discusses the effect of vibration on the building and its foundations, upon the operatives, and upon the textile machinery.

The question of how to eliminate vibrations, and the effect of rigid floors on textile machinery are each discussed briefly. A set of five graphical records, showing the amount of vibration in different parts of a certain mill, are given. The article closes with the expression of opinion that the problem of mill vibration is one deserving much more serious attention and study than has usually been given. F. O. E.

Some Aspects of Recent High Pressure Investigation, by John Johnston, in the January number of the *Journal of the Franklin Institute*, describes apparatus used, and discusses some results of experiments on materials subjected to pressures as high as 20,000 atmospheres.

The author warns against confusing the effects of hydrostatic pressure with those of pressure causing stress (shearing deformation?). For example an explosive may be unaffected by hydrostatic pressure but may be exploded by a comparatively small pressure acting in one direction only. In this connection mention is made of the theory that all permanent deformation of a material is accomplished by a momentary liquifaction of a portion of the material.

Of some interest to engineers is the fact that H_2O which if frozen at pressures below 2,115 atmospheres forms ordinary ice, less dense than water, will if solidified at greater pressure take other crystalline forms more dense than water.

It follows that a pipe capable of withstanding 2,115 atmospheres cannot be ruptured by freezing water.

S. S. G.

Coal Used in Making Gas and Coke. From *Gas Age*, February 1, 1917.

The total quantityof bituminous coal used in making coal gas for municipalities in 1915 was 4,664,795 tons, of which the place of origin of 4,563,579 tons, or 98 per cent of the total, is known, and is shown in the table. Nearly 2,500,000 tons, or 55 per cent of the coal used in making gas (exclusive of that made in by-product ovens), came from Pennsylvania, the excellence of whose Westmoreland and Youghiogheny gas coal is well known. West Virginia supplied 765,000 tons, or 17 per cent, and Kentucky 617,000 tons, or 14 per cent.

The statistics given in the table, showing the quantity of coal used in making beehive and by-product coke, are taken from the U. S. report on coke in 1915, but the table shows also, as nearly as it can be ascertained, the states in which coal used in this industry was mined. All coal coked in beehive ovens, except that so used in Ohio, is considered to have been mined in the state in which it was coked. The statistics showing the states in which the coal used in by-product coke ovens was mined have been compiled in part from returns received from the operators of these ovens and in part from data furnished by the coal operators.

Pennsylvania supplied more than 80 per cent of the coal used in the manufacture of beehive coke, and nearly 33 per cent of that used in by-product ovens. About 40 per cent of the coal utilized in by-product ovens came from West Virginia, 15 per cent from Alabama, and the remainder in small quantities from five other states and Canada.

State in which coal was produced	Manufacture of —beehive coke—		Manufacture of —by-product coke—		Manufacture of —coal gas *a*—	
	Quantity (net tons)	Per cent	Quantity (net tons)	Per cent	Quantity (net tons)	Per cent
Alabama	1,708,228	4.0	2,987,710	15.1	109,160	2.4
Alaska....	......	..	......	..	......	..
Arkansas .	......	..	......	..	......	..
California *b*	......	..	......	..	......	..
Colorado..	1,026,019	2.3	......	..	103,674	2.3
Georgia ..	35,377	.1	......	..	......	..
Illinois ...	......	..	98,073	.5	34,785	.7
Indiana ..	....	....	......	..	60,145	1.3
Iowa	......	..	......	..	......	..
Kansas ...	......	..	......	..	......	..
Kentucky .	462,168	1.0	1,546,834	7.9	616,936	13.5
Maryland .	......	..	156,782	.8	21,000	.5
Michigan .	......	..	......	..	......	..
Missouri ..	......	..	......	..	......	..
Montana..	......	..	......	..	......	..
N. Mexico .	732,830	1.7	......	..	11,187	.2
N.Dakota .	......	..	......	..	......	..
Oho	......	..	......	..	......	..
Oklahoma .	......	..	......	..	9,553	.2
Oregon ...	......	..	......	..	......	..
Penn. ...	33,972,018	81.0	6,421,707	32.8	2,497,216	55.0
S. Dakota .	......	..	......	..	......	..
Tennessee .	433,781	1.0	32,084	.2	62,020	1.3
Texas	......	..	......	..	......	..
Utah	654,387	1.4	......	..	49,615	1.0
Virginia ..	995,396	2.2	......	..	99,149	2.1
Wash.	158,496	.3	46,383	.2	124,093	2.7
W. Va. ...	2,099,816	5.0	7,774,809	40.0	765,046	16.8
Wyoming .	......	..	......	..	......	..
Imports *c*	......	..	490,000	2.5	......	..
	42,278,516	100.0	19,554,3820	100.0	4,563,579	100.0
% total cons'mptn	9.3	..	4.3	..	1.0	..

a Does not include 81,216 tons the origin of which is not known. The total coal used in the manufacture of coal gas was 4,644,795 tons.

b Includes Idaho and Nevada.

c Does not include 841,122 net tons imported, the use of which is not known.

C. A. P.

Continued from page 141

replies to some of these questions are very interesting and give a very good idea of the whole situation.

The following is a summary of the replies received from the central stations:

Q. How long was the student employed?

A. Average time worked was ten weeks.

Q. In what department was student employed?

A. Commercial, 38 per cent; Engineering, 62 per cent.

Q. Was student's work satisfactory?

A. Yes, 93 per cent; fairly, 5 per cent; no, 2 per cent.

Q. If on sales work were services directly profitable to the Comapny?

A. Yes, 98 per cent; no, 2 per cent.

Q. Were services rendered as satisfactory as the service rendered by the average new employee having no technical training?

A. Yes, 72 per cent; more so, 23 per cent; no, 5 per cent.

Q. What remuneration was paid to the student?

A. Average salary paid was $54 per month.

Q. What remuneration was paid to the others employed in the same class of work?

A. Same, 64 per cent; more, 32 per cent; less, 4 per cent.

Q. Did student show adaptability to Central Station work?

A. Yes, 89 per cent; fair, 6 per cent; no, 5 per cent.

Below is a summary of the replies received from the students:

Q. Was the work satisfactory to you?

A. Yes, 90 per cent; fairly so, 3 per cent; no, 7 per cent.

Q. Were the wages satisfactory to you?

A. Yes, 90 per cent; no, 10 per cent.

Q. Do you desire employment by this company next year?

A. Yes, 70 per cent; no, 8 per cent; undecided, 22 per cent.

Q. Do you think a student should work all summer?

A. Yes, 15 per cent; no, 85 per cent.

Q. Or, should he have some vacation?

A. Majority thinks two weeks vacation is enough.

Q. Would you prefer such vacation before or after the summer work?

A. Before, 9 per cent; after, 91 per cent.

Q. From your experience so far, what do you think of the Central Station industry as a field for technically trained men?

A. Good, 93 per cent; poor, 7 per cent.

These replies show that not only were the students pleased with the work, but the companies liked the work that the students did. This is surely a start in the right direction and has accomplished two things; it has shown the central station managers that a college man fits in very well with their business, and it has opened the eyes of a number of students to the great opportunities for advancement which the Central Station field presents to the man with a college training.

No doubt, similar results could be obtained in other fields. With this in view, we would advocate that the Sibley Employment Bureau make a special practice of placing juniors and even sophomores and freshmen in suitable summer positions.

PERSONALS

Herbert Chase, '08, who has been connected with the Automobile Club of America for several years as laboratory engineer and chief engineer, has joined the office staff of the Society of Automobile Engineers in the capacity of assistant secretary. Mr. Chase is treasurer of the society and a member of its Council. He has taken a prominent part in the activities and conduct of the metropolitan section of the society since its organization. He has made numerous contributions of engineering value on tests and testing of motor car engines of the internal combustion type and on the possible uses of cycles other than that of the Otto engine. Mr. Chase's long service on the publication committee of the society will enable him to assume readily editorial work on the Bulletin and other publications of the S. A. E.

Mr. Chase's preparatory engineering education was had at Pratt Institute. He was graduated as a mechanical engineer at Sibley College, Cornell University, in 1908.

Herbert B. Reynolds, '11, M.M.E., '15, presented a paper at the last annual meeting of the American Society of Mechanical Engineers in New York City on "The Flow of Air and Steam Through Orifices." His paper received honorable mention in the junior prize competition for 1916. Reynolds is an engineer in the motive power department of the Interborough Rapid Transit Company, New York City.

Continued on page 10 Adv. Section

UNIVERSITY NOTES

Announcement has been made of the establishment of a $10,000 fund to be known as The Susanna Phelps Gage Fund for Research in Physics in Cornell University. The donors of the fund are Professor S. H. Gage, B.S. '77, and Dr. Henry Phelps Gage, A.B. '08, Ph.D. '11, husband and son respectively of Susanna Phelps Gage, Ph.B., '80, as a memorial of whom it is given. Mrs. Gage was the first woman to take laboratory work in physics in Cornell University, and she showed by her subsequent career the highest appreciation of the need for research in this country.

It is the donors' wish that the income from the fund be expended in any way which in the opinion of the professors of physics, gives promise of advancing knowledge of this subject.

George W. Perkins, chairman of the New York State food and market commission and a member of Mayor Mitchell's food commission in New York, spoke in Bailey Hall at a convocation hour on Monday,

Continued on page 12 Adv. Section

EMPLOYMENT BUREAU, SIBLEY COLLEGE

The Sibley College Employment Bureau desires to be of service to **Alumni** and **Seniors** seeking positions and to **Employers** desiring men. Also it aids **Undergraduates** in securing employment during the **Summer** vacations.

1. ALUMNI EMPLOYMENT

(a) About once a week the Employment Bureau issues **Bulletins** of positions available and sends them to such graduates as may be interested and also to Alumni Clubs and others that may be in touch with those desiring jobs. Sibley Alumni who desire to receive these Bulletins should notify the Sibley Employment Bureau.

(b) Employers having openings for alumni who are prepared for such fields as Mechanical, Electrical, Heat-Power, Hydraulic, Structural, Industrial, Mining and Naval Engineering and allied branches, should send notices to the Sibley Employment Bureau, Ithaca, N. Y. These notices will be published in the Bulletins mentioned above. Each notice should include a brief statement of the kind of position available, or of the character of the work and give the special qualifications required of the candidate or the number of years of experience which he should have had since graduation. When it is possible the notice includes also a statement regarding prospect for advancement and gives approximate idea of the initial salary. If the firm seeking men objects to the use of its name in the Bulletin a reference number is substituted and in that case applicants can be put in communication with the firm through the Bureau. The use of the firm's name is preferred, however, as it avoids delay.

(c) If desired, the Bureau can arrange with THE SIBLEY JOURNAL OF ENGINEERING which goes monthly to many graduates, to publish similar brief notices without charge. The information for such notices should be sent to the Employment Bureau before the 25th of the month.

2. EMPLOYMENT OF SENIORS

(a) Employers usually find it more satisfactory to send representatives to Sibley College to make personal selection from the members of the senior class, than to attempt a choice by correspondence. The preferred procedure is as follows: A week or more before the visit a letter should be sent to the Bureau outlining the character of the work to be done in the positions to be filled, the qualifications desired, the opportunities for advancement, initial salary, etc., and giving the probable time of arrival of the representative. This letter is then posted on the Bulletin Board so that the students may become **familiar** with the proposition and, if interested, be better prepared to talk with the representative and make a decision if an offer is made. A group picture of the Sibley Senior class (about 190 members) can be furnished to the representative, and the scholarship records are available for consultation.

(b) If it is desired to conduct the matter entirely by correspondence, it is suggested that a letter similar to the one outlined above be sent for posting, after which a senior picture will be forwarded with such applications as are made. If desired, the Bureau will give what assistance it can in making selections, although it is often difficult to predict on the basis of the University record the future success of a student, as many men who are unsatisfactory students become very effective in business under right conditions.

3. SUMMER EMPLOYMENT

Many students desire positions during the Summer vacation some with the object of earning funds for the continuance of their education, others primarily to gain experience or to get established with a view to employment after graduation. A few of these men are skilled in some trade. Employers who have summer positions for such students should send to the Bureau a letter outlining the proposition completely, so this letter can be posted on the Bulletin Board.

EMPLOYMENT NOTES

326.* A firm which publishes several engineering and trade papers desires to employ some recent graduates with view for training them for higher positions in their business. Location—New York City.

327. Mr. A. J. Abels, Care A. J. Abels Co., Brisbane Bldg., Buffalo, N. Y., having sales rights for many manufacturers of factory, heating and power plant equipment, wants recent graduate as sales engineer. If man is inexperienced, he will be given suitable training.

328. Mr. Harry C. Herpel, '06, Chief Engineer of Page-Hersey Iron, Tube and Lead Co., Welland, Ont., wants three designers familiar with rolling mill machinery and three detail draftsmen.

330. Mr. W. N. Hollenbeck, District Plant Supt. of N. Y. Telephone Co., Elmira, N. Y., wants two or three recent graduates for Plant Dept. of the Telephone Co.

331. Mr. J. H. Barnes, Master Mechanic, Maxwell Motor Co., Dayton, Ohio, has opening in his office for recent graduate. "This is an excellent opportunity for a young man, as the field is so varied, including as it does, property and machine layouts, steam, gas, compressed air and electrical installations, also experimental tool and machine design. . . . The commencing salary could be $20 per week, with increase as soon as the factory system is mastered."

332. Mr. F. H. Montgomery, Treas., Crofut and Knapp Co., South Norwalk, Conn., (Knapp Felt Hats) wants young man who has specialized in industrial and efficiency engineering. "A young man capable of organizing and handling a planning department and creating and filling the position of works manager. . . . The position offers unusual opportunities for the future."

333. Mr. J. D. Moomey, Sales Manager, Hyatt Roller Bearing Co., Newark, N. J., wants several recent graduates for sales in old and newly developed lines, and one man is wanted for advertising and to take care of writing the several house organs. "The Hyatt Company is a fine company to work for in that it pays fairly and is growing and expanding constantly so that a man's chances of advancement are commensurate with his own growth."

334. Mr. Norman Dodge, B.S., 1900, General Manager, Mergenthaler Linotype Co., Tribune Building, New York City, wants one or two men with some years of practical experience and with ability to handle and deal with other men. There are good prospects for advancement. Also there are openings for several recent graduates.

335. "The Bell Telephone Co., of Pennsylvania wishes to engage a Mechanical Engineer who has had experience with automobiles and trucks. The position offers an opportunity to become familiar with various types of automobile machinery and appliances; to design special equipment and make tests on internal combustion engines, fuels and lubricating oils. The work will be in Philadelphia. Apply to Mr. H. N. Reeves, Supervisor of Supplies and Motor Vehicles, 1230 Arch St., Philadelphia."

336. Mr. H. M. Pierce, Chief Engineer, Engineering Dept., E. I. duPont de Nemours and Co., Wilmington, Del., wants draftsmen of at least eight years' experience, including machinery detailing and designing, general drafting and designing, such as transmission machinery and apparatus layout.

337. Mr. W. H. Grady, Asst. Genl.Supt., American Creosoting Co., 401 W. Main St., Louisville, Ky., wants recent graduates to place in some of their plants to train for more responsible positions which they have to fill from time to time. Start at $75 with actual operation of processes. "We believe they will find good opportunity for advancement in this kind of work."

339.* A firm in Massachusetts making wood screws, machine screws, nuts and specialties desires young man to take charge of their mill-wright and engineering work.

341. Mr. Hart O. Berg, Care Engineers' Club, 32 W. 40th St., New York City, wants men to operate portable refrigerating machines in the Hospital service near the Front in France. Only expenses furnished; connection with French Army.

342. Mr. W. L. Rogers, United Motors Corporation, Suite 1809, Aeolian Building, New York, is compiling list of experienced men, particularly those with executive ability, with view to having them available for filling positions as they develop in the various concerns controlled by the United Motors Corporation. Men should have had five or six years' practical experience.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI APRIL, 1917 No. 7

THE SIBLEY JOURNAL OF ENGINEERING

SIBLEY COLLEGE, CORNELL UNIVERSITY

Editor—JOSEPH A. BECKER

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year
Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR APRIL, 1917

Greetings from Sibley Alumni

It is a happy idea of the management of THE SIBLEY JOURNAL OF ENGINEERING that Sibley men of the past should produce a special issue of THE JOURNAL for the Sibley men of the present.

The university is an undertaking in which the younger generation may meet with some of the older generation to accomplish improved preparation for the part that will be theirs later on. Who of the older generation should thus be called to make and maintain the University? Surely, they should be representatives of all whose work is worthy of an advancing civilization. Yet no possible faculty can include them all.

Cornell was founded by men who understood these things clearly. We know this by what they did. Provision was made at the outstart for the Alumni to take an active part in the maintenance and progress of the University. Her founder-president pioneered in the effort to have leaders in thought and action, the world over, come to the University that the young people might see and hear them. No university has been more loyal to its young people than Cornell. No Alma Mater is more beloved by her children. We, of her Sibley Alumni, rejoice in this opportunity to tell of things as we find them for the interest and benefit of the Sibley men of to-day. To them our hearty greetings and good wishes!

HARRIS J. RYAN, '87.*

Judgment in Engineering Problems

At the recent A. I. E. E. mid-winter convention in New York City, Dr. C. R. Mann made some preliminary statements regarding the forthcoming report of the joint committee on engineering education. This committee represents a number of engineering societies and Dr. Mann was detailed by the Carnegie Association for the Advancement of Teaching to make a special research for the joint committee. Among other interesting things, Dr. Mann told the electrical engineers that engineering education is quite a different matter from what it was fifty years ago. Then the engineering school based its instruction on scientific principles alone, but now the solution of labor and other human problems in a scientific manner has come to be of vital importance. Just what Dr. Mann meant in detail will be evident after the joint committee's comprehensive report has been issued, but whatever the report says there is one element

Continued on page 10 ad

*Prof. of Elec. Eng. Leland Stanford Univ., formerly Head of Dept. at Cornell Univ.

INDUSTRIAL POWER

DAVID B. RUSHMORE, '95*

The industries of this country are at the present taxed to their utmost and the very fact that they are able to turn out their products at this enormous rate must truly be contributed to our ability of generating and utilizing power in such forms that it can readily be substituted for the physical work of man. Electricity is not a source of energy in itself, but is obtained either directly or indirectly by transformation of energy in either a chemical or mechanical form, such as with steam and water power. It is the most convenient form in which energy can be transmitted and distributed, but for all practical purposes it must again be transformed before being utilized, as for example, by the electric motor.

The two chief advantages of the electric drive for industrial machinery are: An increased production for a given equipment with an improved product, and a decreased power consumption with higher efficiency. This is due to the possibilities of centralizing the power supply; the simplicity of transmission and distribution; the possibility of conveniently locating the machinery with reference to production rather than to the power transmitting system; reduced friction losses; better control; less danger of accidents; etc.

It is difficult to accurately estimate the total mechanical horsepower used in the United States, but the following table should give a fairly close approximation.

TABLE I

Manufacturers	25,000,000 h.p
Central Stations	8,500,000 "
Isolated Plants	4,500,000 "
Street and Electric Railways	4,000,000 "
Steam Railroads	50,000,000 "
Steam and Naval Vessels	5,000,000 "
Mines and Quarries	6,000,000 "
Flour, Grist and Saw Mills	1,500,000 "
Irrigation	500,000 "
Automobiles	50,000,000 "
Horses and Mules	25,000,000 "
Total	180,000,000 h.p.

This is equal approximately to 1.80 horse power per capita.

The rapid growth in central electric power stations, as taken from the latest census report, is shown in Table II, and, aside from the growth in the number of stations, the striking features of this table are the relatively large increase in the kilowatt capacity per station, with the cost of construction and equipment remaining practically the same. That this cost has not been materially reduced is no doubt due to the

CENTRAL ELECTRIC LIGHT AND POWER STATIONS
TABLE II

	1912	1907	1902	Per cent of increase 1902–1912
Number of stations*	5,221	4,714	3,620	44.2
Commercial	3,659	3,462	2,805	30.4
Municipal	1,562	1,252	815	91.7
Total income	$302,115,599	$175,642,338	$85,700,605	252.5
Light, heat, and power, including free service	$286,980,858	$169,614,691	$84,186,605	240.9
All other sources	$15,134,741	$6,027,647	$1,514,000	899.7
Total expenses, including salaries and wages	$234,419,478	$134,196,911	$68,081,375	244.3
Total number of persons employed	79,335	47,632	30,326	161.6
Total horse power	7,528,648	4,098,188	1,845,048	308.0
Steam engines and steam turbines:				
Number	7,844	8,054	6,295	24.6
Horse power	4,946,532	2,693,273	1,394,395	254.6
Waterwheels				
Number	2,933	2,481	1,390	111.0
Horse power	2,471,081	1,349,087	438,472	463.6
Gas and oil engines:				
Number	1,116	463	165	576.4
Horse power	111,035	55,828	12,181	811.5
Kilowatt capacity of dynamos	5,134,689	2,709,225	1,212,235	323.6
Kilowatt capacity per station	983	574	334	194.3
Cost of contruction and equipment	$2,175,678,266	$1,096,913,622	$504,740,352	331.4
Cost per kilowatt capacity	$425	$404	$416	
Output of stations, kilowatt-hours	11,502,963,006	5,862,276,737	2,507,051,115	358.8
Estimated number of lamps wired for service:				
Arc	505,395	562,795	385,698	31.0
Incandescent and other varieties	76,507,142	41,876,332	18,194,044	320.5
Stationary motors served:				
Number	435,473	167,184	101,064	330.9
Horse power capacity	4,130,619	1,649,026	438,005	843.1

*The term "station" as here used may represent a single electric station or a number of stations operated under the same ownership.

*Engineer, Power and Mining Dept., General Electric Co.

increased cost of the distributing and transmission lines, which form an important part of the total cost of the system.

Table III gives the horse power of electric motors used in some of the leading manufacturing industries, for the years 1899–1904–1909. The horse power required per $1000 value of product and per person engaged in the industries is given in Table IV.

TABLE III

Electric Motors in Leading Manufacturing Industries

	Horse power		
	1909	1904	1899
Agricultural Implements	38,905	20,713	7,643
Automobiles	41,829	4,229	
Car and Railroad Repair Shops	161,288	52,635	4,563
Cement	158,749	35,292	
Cotton Goods	235,902	67,139	17,594
Electrical Machinery	164,540	61,753	24,256
Foundry and Machine Shops	623,914	199,625	54,907
Iron and Steel—Blast Furnaces	135,143	52,610	8,693
Iron and Steel—Rolling Mills	716,609	254,258	64,658
Lumber and Timber Products	130,707	33,517	11,315
Paper and Wood Pulp	130,120	31,604	2,814
Printing and Publishing	229,312	93,219	41,413
Total	4,817,140	1,592,475	492,936

TABLE IV

Power Required for Manufacturing Based on 1909 U. S. Census

	Horse power Required per $1000 Production	Horse power Used per Person Engaged in Industry
Agricultural Implements	0.69	1.67
Automobiles	0.30	0.89
Boots and Shoes	0.19	0.45
Brick and Tile	3.68	4.00
Cement	5.90	12.60
Chemicals	1.78	7.50
Copper, Tin and Sheet-Iron Products	0.31	0.72
Cotton Goods	2.07	3.35
Electrical Machinery	0.72	1.50
Fertilizers	0.62	2.95
Flour and Grist-Mill Products	0.97	12.90
Foundry and Machine Shops	0.71	1.41
Manufactured Ice	7.40	15.05
Iron and Steel—Blast Furnaces	3.00	27.30
Iron and Steel—Rolling Mills	2.13	8.06
Leather—Tanned, Curried and Finished	0.45	2.21
Lumber and Timber	2.46	3.62
Paper and Wood Pulp	4.88	16.05
Printing and Publishing	0.40	0.77
Packing Houses	0.15	1.92
Copper Smelting and Refining	0.42	9.41
Woolen, Worsted and Felt Goods	0.83	2.06
Total—All Industries 1909	0.91	2.45
1904	0.91	2.17

Generation—There is a strong tendency toward consolidating smaller and less efficient generating stations with a view of concentrating the power supply of a territory in one system. So, for example, a supply company in a large city expands so as to embrace the whole district around it, and the service given originally within a small area is unified over sometimes hundreds of square miles. In other cases the properties in a given territory are merged and brought under one management, or groups of established systems located in vastly different localities may be brought together under one holding company. It is to the creation of such companies that in many instances the high-class service and financial success of many small and medium-size light and power

Fig. 1. Power House, Dam, Lock and Dry Dock, Mississippi River Power Company, Keokuk, Iowa.

systems must be attributed. The economies due to a central management, the benefits of the best technical and expert advice applied even to the smallest central station, the cumulative effect of active up-to-date new-business campaigns at every point; all have contributed to an improved and cheaper service to the consumer. Without the facilities of such a control, they could exist only in the larger communities. Another very important advantage is the great problem of financing all these undertakings and providing funds for extensions to meet the ever-growing demand of the public for electric service.

The inter-connection of hydro-electric transmission systems is also a step in the right direction, as demonstrated in our Southern States, where half a dozen large systems are tied together, furnishing power to each other on an "interchange" contract basis. The advantages of this are obvious. The peak loads of the different systems may not coincide, the minimum stream flow may occur at different times on the different water

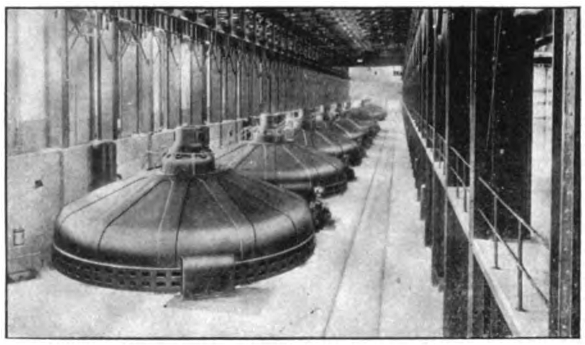


Fig. 2. 10000 KV-A-53 R. P. M.-6600 V. Generators, Cedar Rapids Manufacturing and Power Company.

sheds, common steam reserve stations may be used, and in general the operation may be so improved that a most efficient and reliable service can be rendered the customers of all the systems so tied together.

The steam turbine and the waterwheel stand foremost for the generation of electric power and it is astonishing the rate at which the size as well as efficiency of these generating units have increased of late. Steam turbine units are now being built in capacities of 50,000 kw. and waterwheel-driven units of 20,000 kw., with

every prospect of this being considerably increased. These large steam turbines show a performance representing the maximum turbine efficiency so far obtained. This high efficiency also is closely sustained over the greater part of the load range of the machine. The advantage of this where machines are frequently required to operate over considerable variations in load, is apparent. In fact, the useful capacity of a turbine is determined by the shape of its load-water rate curve rather than by an arbitrary rating assigned to it by the manufacturer. In general, any turbine can be made to carry a load considerably in excess of the most economical load, either by permitting congestion of steam in the low-pressure end, or by by-passing live steam to buckets operating at intermediate pressure. This practice is only justified to a limited extent. That is, an increase of a few percent in steam consumption at the maximum load, over that of the most economical point, is permissible, in order to insure good light load economy. But where a small machine is given a very large arbitrary rating, and the maximum load secured at the sacrifice of economy at high loads, the actual useful capacity is not the maximum rating assigned to the machine, but some lower value, determined by the economical range

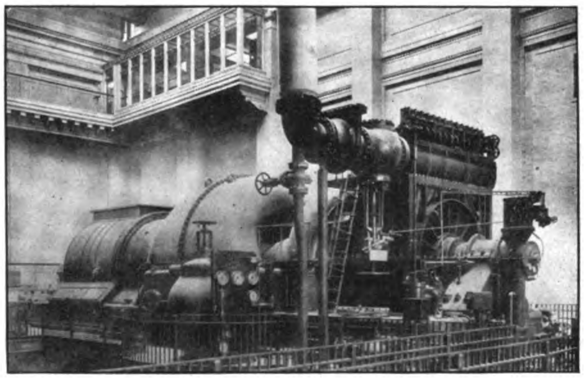


FIG. 3. 35,000 KW Curtis Steam Turbine, Philadelphia Electric Company, Philadelphia, Pa.

beyond the best point. The best practice is therefore to so rate turbines that the steam consumption of the machine at its maximum continuous rated load will not differ greatly from that at the point of highest economy.

Hydraulic turbine design has also passed through a stage of wonderful development during the past few years and remarkable progress has been made toward bringing the turbine to a high state of perfection. Ten years ago it was considered a notable achievement to obtain a turbine with an efficiency as high as 82 per cent while to-day a maximum value of nearly 94 per cent has been secured. This remarkable increase in efficiency is by no means entirely due to superior runner design. As a matter of fact, the improvements in the design of wheel-casings, wicket gates, draft chests and draft tubes have increased the efficiency of the turbine as much as the more efficient runners.

Transmission—The high-voltage transmission system has undergone an evolution from the single transmission line with a power station at one end and with a receiving circuit at the other, until it is more nearly a high-voltage distributing system into which network are fed a number of steam and hydro-electric power stations, and from which at various points are tapped off distributing systems of lower voltage which feed local communities, many of which secondary systems extend over a very considerable area.

For the transmission and distribution of electric energy the voltage continues to rise as the distance and the amount of power to be transmitted increase, and this in turn presents new problems of design and construction. This involves mainly the transformers, the line structure and the switching equipment.

As long as the transmission voltage and the capacity of the generating stations were moderate, no serious operating difficulties were experienced. With the introduction of transmission pressures of 100,000 volts and above, and with the concentration of enormous amounts of power in our modern power stations, problems arose which were solved only after very painstaking investigations and great expense. So, for example, have the transformer interruptions been reduced to a minimum by embodying designs which will make them safely withstand the excessive voltages which may be set up in the system under transient conditions, while on the other hand they are now capable of withstanding the severe mechanical stresses imposed on the windings under short-circuit conditions.

On account of its exposed position, the transmission line continues to be the weakest link in a high-tension transmission system and even the failure of a single insulator may cause a complete shut-down of the entire system. While very great and encouraging improvements have of late been made in the design of insulators and in the methods of testing for weeding out the defective units, it can, however, not as yet be said that the insulator problem is solved.

The question of regulation of large high-voltage systems involves a number of difficulties not encountered in low-voltage work. In the latter case the energy loss is generally the limiting factor and the regulation can often be improved by installing larger conductors, which at the same time will reduce the line loss. With high-voltage systems the gain of doing so is very slight and other means must be resorted to for keeping the regulation within commercial limits. The effect of the inductance and capacity of the line causes the voltage to vary within very wide limits from full to no load. At no load the large capacity current causes a rise of voltage from the generating station to the receiving end, while at full load the lagging inductive current taken by the load, in general, more than offsets the effect of the capacity current and causes a drop of voltage from the generating station to the receiving end. It is evident then that by installing a synchronous condenser at the receiving end, and taking advantage of the characteristics of this machine, the receiving voltage can be kept constant at a determined value by adjusting the synchronous condenser field, causing the condenser to draw a lagging current from the line at no load and a leading current at full load.

The engineering problems in connection with the operation of these high-voltage systems are very largely those which have to do with preventing interruptions to service, and isolating and localizing the electrical disturbances before they can become of a general nature. This involves itself not only into the general design of the apparatus and transmission lines but also to a careful study of the best system of connections and switching equipment. Reliability and continuity of service are the main considerations, but besides this the protection of apparatus from injury should be very carefully considered.

Applications—During recent years there has been a very large increase in the number and variety of electric power applications. Among the more important industries affected may be mentioned: agricultural work including irrigation, textile mills, mining and steel works, electro-chemical work, railroad electrification, etc.

The unqualified success that the application of electric power has had in farming and agricultural work indicates that it has become a factor of such importance that it must now be seriously considered as affecting both the cost and quality of the products of the modern farm. Compared with other forms of applied power, it is more reliable, safer and cleaner and allows a greater flexibility of application. It can be supplied from extensive networks of high tension transmission lines which are now being erected in so many sections of the country, and it can readily and economically be distributed to the scattered location of the various farm buildings where the cost of providing separate engines would be practically prohibitive. Fire risk is reduced to a minimum which is of the greatest importance on isolated farms where fire-fighting appliances are limited.

The advantages of electric power for irrigation purposes have been clearly demonstrated by the excellent work which has been done, and is being done by the U. S. Reclamation Service and numerous co-operative and individual enterprises.

For mining and steel mill operations the advantages of using electric power is also now fully recognized, almost all new installations being equipped for electric drive and a large number of old ones are changing over to this system. In mines especially the electric system eliminates long and expensive steam and air lines with which the danger of breakdown and the difficulty of keeping up the necesssary working pressure increase with every extension to the service. Electric distribution, on the other hand, is more simple and flexible. Very large districts can be efficiently supplied and additions or alterations can at all times be made without the least difficulty. The application of motors to the various machines is readily accomplished. They can be direct connected or geared to the driving shafts, thus reducing the friction losses and repair charges to a considerable extent. Individual motors may be substituted for machinery which was formerly equipped for group operation driven by means of inefficient engines. Operation with the electric system is very simple and results in a materially increased output. Perfect control and simple automatic safety devices can be installed and indicating or recording meters can be provided as desired, and the performance of each individual machine readily ascertained. This is a very important point, as it is possible to maintain the machinery in the best condition and any excess consumption of power can at once be detected and the defect remedied.

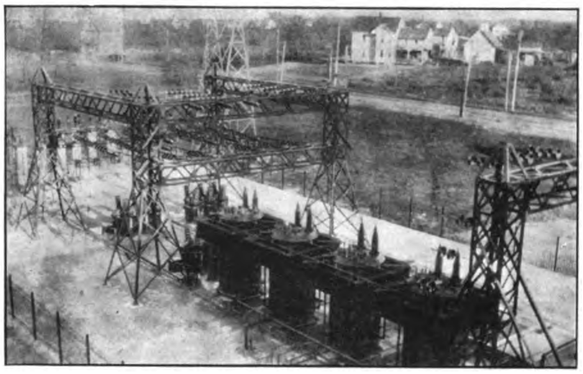


Fig. 4. 66000 Volt Outdoor Sub-station of the Amherst Power Company, Chicopee and Agawam, Mass.

The industrial processes founded on electro-chemistry have a large and important part in the manufacture of a very wide range of commercial products such as fertilizers, explosives, paper, wood pulp, and numerous electro-chemicals among which may be mentioned: aluminum, carborundum, alundum, silicon, graphite, calcium-carbide, cyanamid, ferro-silicon, ferro-chromium, ferro-manganese, caustic soda, sodium, chlorine, chloride, chloroform, etc.

Cheap electric power is vital in connection with electro-chemical industries but, on the other hand, the location of raw materials and the transportation facilities of the product to the market centers is also of the greatest importance. This latter point has, to a great extent, been detrimental to a much greater development of the Western water powers for electro-chemical products. Niagara Falls, on the other hand, forms an ideal example of what cheap water power has done for this industry.

Fig. 5. B. A. & P. Railway Ore Train: 65 cars; 4550 tons trailing.

Another great need for the immediate development of additional water power is the imperative necessity of increasing our nitrate supply and making it independent

of foreign deposits. Fixed nitrogen is the most important constituent of plant food and is absolutely indispensable in the manufacture of explosives. Statistics show that Europe uses per acre of cultivated land 200 lbs. of fertilizer, the United States only 28 lbs. and the need of an increased supply is therefore apparent.

As a measure of preparedness our reserve stock of nitrates is insignificant and our nation would practically be powerless if our navy were not strong enough to protect our import from Chile. Fortunately enough, however, nitrates can readily be extracted from the atmosphere and fixed as a compound by the utilization of electric energy. In Norway with its cheap water powers, this industry has long been established, about 350,000 h. p. being at present utilized by one company alone for the fixation of nitrogen.

Power requirements vary widely for the different electro-chemical products, as seem from Table V, and in many instances it is a large item in the cost sheet of the product.

The enormous amount of electric energy which is used for driving our street and interurban railways is well known. It will also undoubtedly play a very important part in the future in connection with railroad electrification, especially in the Western mountainous states. Four hundred and forty miles of the main line of the Chicago, Milwaukee and St. Paul railroad have now been equipped for operation by electricity and it is contemplated to double the zone of electrification. In view of the economical effect of this installation, other large transcontinental roads are now earnestly considering following the example of the above railroad.

TABLE V

Power Consumption of Electro-Chemical Processes per ton of 2000 lbs.

Refining of Lead	120 kw. hrs.
Refining of Copper	300 kw. hrs.
Refining of Steel	600–1000 kw. hrs.
Refining of Nickel	3000 kw. hrs.
Refining of Zinc	3500 kw. hrs.
Reduction of Calcium Carbide	4000 kw. hrs.
Reduction of Ferro-Alloys	4000–12000 kw. hrs.
Reduction of Abrasives	7500 kw. hrs.
Reduction of Aluminum	30000 kw. hrs.
Pig Iron From Ore	2000–3000 kw. hrs.
Brass Melting	220–280 kw. hrs.
Nitrogen (Fixed N.)	15000–60000 kw. hrs.

SOME TENDENCIES IN THE ELECTRIC RAILWAY INDUSTRY

By MORRIS BUCK, '04*

In the industrial world generally the most recent inventions have had the most rapid growth. This has been the case especially in all the phases of the electrical business; and of none has it been more true than of electric transportation. Although electric railways were conceived in the early part of the nineteenth century, the commercial development did not really begin until the year 1888, the road in Richmond equipped by Sprague being usually credited as the first practical electric line. The development of street railways was quite rapid from that time, until by the end of the century practically every existing horse car line in the United States and most of those in Europe were equipped with the new motive power.

Since then the growth in mileage of electrically operated city roads has been due to the construction of new track.

The use of electricity on trunk lines is a much more recent development. This application was talked of for years, but the first road employing electric power for main line haulage was the Baltimore and Ohio, which equipped the Baltimore Belt Line tunnel with electric locomotives in 1895. Even this installation was rather premature, and many years passed before another railroad was brave enough to supplant the steam engine. With the installations on the roads centering in New York City, beginning in 1906, a practical demonstration of the advantages of electricity was made that has been a strong argument in favor of this motive power. Other lines have been equipped for electric operation, and in every case have been successful, so that no doubt remains in the minds of engineers as to the feasibility of electrification in general.

In spite of the pioneer work just mentioned steam railway operators have not been quick to grasp the advantages which have been set forth by their electrical engineers. The reasons for this are obscure to the layman, but are not difficult to find. For one thing, until recently all of the installations were made for more or less special purposes, such as making tunnels safe, relieving the smoke nuisance, or giving better suburban passenger service. The electrified lines have earned handsome interest on the added investment, but the conservative financier has not been willing to accept this as proof that the same results can be obtained in other cases where the conditions are more or less different. This leads to the second and compelling objection. No project is successful in the practical world unless it can pay its own way, and no matter how good the arguments on paper, investors as a class have not been willing to risk sinking their money unless the prospect of return is quite good. Government regulation of the railways in respect to rates and operating conditions generally have made it difficult to earn more than a

*Assistant Professor of Railway Electrical Engineering, University of Illinois.

nominal interest on the investment, so that the railroads have found it almost impossible to obtain funds for normal betterments, to say nothing of special improvements such as electrification. For this reason alone railroads have been obliged to defer consideration of such changes until either the probable net earnings have been shown much in excess of the ordinary return, or else until the money market is easier.

It remained for two enterprising railroads to assume the risk and install electric equipment in the past two years. These are the Norfolk & Western and the Chicago, Milwaukee & St. Paul. How the money was obtained is another story, but it is enough to say that the financial interests back of these roads had the courage to go ahead and take the risk incident to the installation of what, to the steam railroad man, has been a radical innovation. Electrical engineers have been found willing to stake their reputations on the success of these installations, although it is only fair to say that they knew the risk of failure was small. Convincing the public has been the only difficult part of the entire matter. How well this latter has been done is now common knowledge. In both cases the results obtained from the new equipment have so far exceeded the expectations that competent steam railway operators have been amazed. The direct savings have been much more than estimated, and the other features of operation have made possible additional economies which could never have been attained with steam.

Of the two installations referred to, the Norfolk and Western carries far the heavier traffic. The number of trains and their weight was such that under steam conditions the limit of capacity of the tracks had been reached, and the road faced the necessity of either increasing the number of tracks or of using electric power. The latter alternative has been adopted, and has made it possible to so greatly increase the tonnage handled that track changes have been indefinitely postponed.

The Chicago, Milwaukee & St. Paul installation is quite different in character. The portion of the road electrified is a part of the Pacific Coast extension, and is the newest of the transcontinental lines, having been completed within the past ten years. The traffic handled is light, but the trainloads are heavy. To the casual observer this would seem to be a condition offering the least possible advantage to electric operation. There are, however, several factors which have made the proposition more attractive than would appear at first sight. The grades are long and steep, the route passing over four mountain ranges including the Rockies. The coal in the territory through which the road runs, Montana and Idaho, is of poor quality, and the water is hard on the boilers, forming scale which soon requires removal. Contrasted with this, a large amount of water power is available at a comparatively low cost for development. When preparations were made to finance the installation it was found that an existing power company was willing to produce and deliver the necessary electric power at a very attractive figure, so that the burden for this portion, amounting to nearly one-half of the total cost of the electrification, did not need to be assumed by the railroad. As a result of all these contributing factors the railroad has recently completed the electrification of 440 route miles between Harlowton, Montana, and Avery, Idaho.

A statement of the results obtained would take too much space in an article of this character. I can add nothing to the statement of Mr. C. A. Goodnow, the official in charge of the work, who says*

"Electrification has been such a tremendous success on the Milwaukee road that it is difficult to state the results without seeming exaggeration, but I think it quite within the fact to say that the Milwaukee road has forgotten that the Continental Divide exists."

While no definite figures are available at the present time, it seems probable that the earning on the added investment will be from 20 per cent to 30 per cent. This is sufficient to attract even the most conservative investor; and when it is realized that this earning is based on results obtained from a road with sparse traffic, which has usually been considered a poor field for electrification, the wonderful character of the achievement can be still better appreciated.

The results from this installation will be far-reaching. The same railway has just announced that it will immediately electrify for a distance of approximately 200 miles east from Seattle; and projected installations on other roads are reported almost weekly. It is idle to guess at the possibilities for the future but that they are great is now a certainty.

Steam railroad electrification is so spectacular that we are apt to forget that chances for improvement exist on the street and interurban railways throughout the country. Electric power has now been used on these for many years, but since the completion of the early pioneer work the methods have been quite well standardized. The efforts of electric railway engineers have been largely directed to refinement of apparatus, while keeping the essential features of operation the same. The development has been so rapid that it is now almost impossible for a railway to standardize on a certain type of equipment with any assurance that it will pay to wear it out in service. This condition is especially true of motors and control. The introduction of commutating poles in direct-current series motors has not only made possible the high-tension systems used on some trunk lines, but has made a tremendous saving in cost of maintenance of motors on city roads.

The high-tension systems, while they have been installed on a few interurban lines, are not by any means so widely used as they might be with profit. Voltage regulation on most of our interurban roads is bad, and, at the present price of copper, there is little hope of improving it while using the same system. If the contact line potential could be changed from the

*Some Practical Results Obtained by Electrification on the Chicago, Milwaukee & St. Paul Railway, by C. A. Goodnow, Assistant to the President; *General Electric Review*, November, 1916.

old standard of 600 volts to 1200 volts there would be possible an enormous saving in copper, in line loss, and perhaps in the number of substations required.

Another possibility in this connection is the development of the automatic substation. It has been found that on many lines the substations are needed but a few hours a day, but are kept running all the time. Automatic equipment is now available which will start the substation machinery when the load comes on, synchronize and tie it in, take care of line troubles, and shut down the machinery when the demand has passed. A few inspectors can take care of the substations for an extensive road. A still more potent possibility in this direction is the use of the mercury vapor rectifier. At least one road is now using this device for changing from alternating current to direct in place of the ordinary synchronous converter. The operation of the rectifier can also be made automatic, if required.

Great possibilities exist in regenerative control. It is an attractive proposition to convert the kinetic energy of a moving car into electricity, to help out at other points. Practically, nothing has been accomplished in this direction up to the present, except for heavy trunk line service. Many inventors have worked on the problem, but have not thus far produced practical solutions.

Apart from the developments in apparatus, there are possibilities that the existing equipment is not being used to the best advantage. For instance, the distance between stops has a very marked influence on the energy consumption and the schedule speed of an electric car. According to old notions it is necessary to stop every car at every street corner on demand. This results in excessive cost of operation, and in the end causes a lack of facilities for the patrons of the road. As an example, a certain car can make a schedule speed of 9.8 miles per hour if the distance between stops is one-tenth mile, but if the stops are one-fifth mile apart the schedule speed will be increased to 13.7 miles per hour. The corresponding energy consumption is 193 watt-hours per ton-mile with the one-tenth mile run, and 140 with the one-fifth mile run. The adoption of the smaller number of stops will cause a greater walk for only a part of the passengers, but will give a higher schedule for all.

Proper acceleration and braking will cause great saving in energy consumption, while maintaining the same schedule. Some roads have found it possible to save from 15 per cent to 25 per cent. by increasing the accelerating and braking rates. The time gained by more efficient operation is used in coasting, during which time the car is propelled a part of the distance by its own momentum.

Another recent innovation is the use of low-floor cars, with the possibility of speeding up the traffic and reducing the time of stops. The value of a second saved at a single stop may be small, but if this time is saved at every stop, the total may be tremendous. For instance, one large system has estimated that the reduction of the time of each stop by one second would result in a net reduction of the cost of platform labor amounting in a year to $35,000.

Great advances have also been made in car design by the reduction of weight in various parts of the rolling stock. Roughly, the cost of hauling one pound of material in a street car will cost from three cents to five cents per year. It has been found possible to build modern cars weighing about 36,000 pounds to do the same work as older designs weighing 44,000 pounds. This will result in a saving of from $240 to $400 per car per year, in addition to the reduction of load on the power plant and electric distribution system. This is certainly worth consideration by any road.

A factor which must not be overlooked in this connection is the commercial value of improvements such as those suggested above. Passengers like to ride in new and improved cars. Good schedules, good lighting and ventilation, and a general display of alertness are appreciated by the public, and tend to increase the habit of riding, resulting in greater gross earnings. While the electric roads have in the past been slow to recognize the value of public opinion there is every indication that they are now fully awake to the advantages to be gained by pleasing their patrons. Cooperation of this sort will result in much benefit for both parties.

Careful analysis of the city railway problem has shown that many opportunities for saving are being missed, and that a few minor changes in equipment and in operating methods will cause a tremendous improvement in service. Such factors as those discussed above as well as many others, will make great variations in the cost of the service and in the gross receipts which may be expected. In these days of conservation and cooperation, opportunities for improvement should not pass unnoticed, advantage should be taken of them so as to get as much as possible out of the badly overworked nickel, before an appeal is made for higher fares or curtailment of service. It may be seen that such possibilities open up a tremendous field for study, with chances for the application of the best engineering talent available.

TRANSMISSION LINES

JULIAN C. SMITH, '00*

Transmission line practice at the present time seems to be becoming somewhat standardized.

There are four classes into which transmission lines may be divided by reason of their importance, i.e.

1. Main trunk lines, usually consisting of steel tower supporting structures, carrying two circuits with voltages from 80,000 to 150,000 volts. These lines are normally designed for at least 15,000 kilowatts per circuit, and up to 50,000 kilowatts per circuit.

2. Main lines, consisting of single or double circuits supported by latticed steel poles or wood poles, with voltages ranging from 30,000 to 66,000 volts. These circuits are normally designed for amounts of power ranging from 5000 to 10,000 kilowatts per circuit.

3. Relatively short lines transmitting large amounts of power; consisting of single circuit wood pole construction or double circuit steel pole construction, with voltages ranging from 15,000 to 30,000 volts. There is another class of transmission line operating at from 15,000 to 30,000 volts, but transmitting small amounts of power, these lines are usually cheaply built, consisting of wood pole lines, with the minimum amount of copper. Such lines transmit from 1000 to 5000 kilowatts at distances up to 25 to 30 miles.

The last classification indicated above will not be discussed in this article, as it is properly speaking a part of a distribution system, and not an ordinary transmission line.

The voltages, frequencies, and types of construction of these various classifications, have gradually narrowed down to comparatively few in number.

There are certain standard voltages in use to-day such as 13,200, 25,000, 33,000, 44,000, 66,000, 88,000, 110,000, and in a few cases still higher voltages up to 150,000 volts.

The frequencey has generally become standardized at 60-cycles. There are many examples of 25-cycle systems, and a few examples of other frequencies such as 30-cycles and 50-cycles in the United States and Canada. The present practice, however, seems to be gradually supplanting the other frequencies with 60-cycles. Most new systems, unless there are determining features caused largely by previous installations, have adopted 60-cycles as their frequency.

The development of transmission lines has followed closely the development of the railway construction and operation.

1. Short lines were built between important centres.
2. Additions were made to these lines to bring in out-lying districts.
3. Adjacent systems were connected together.
4. Main trunk lines were established, which were used for heavy service.

As an example of this may be taken the conditions in eastern Canada.

Starting at Quebec, a line extends from Quebec to Shawinigan Falls, a distance of a little under 100 miles. From Shawinigan Falls a line extends westward for about 100 miles to Montreal. A line from Montreal also extends westward to Cedar Rapids, a distance of about 30 miles. From Cedar Rapids the line extends westward to Massena, N. Y., a distance of about 60 miles, and from Massena southward into the State of New York branch lines extend a distance of about 50 miles.

On the Canadian side of the border, there is a gap of about 75 miles, extending from Cornwall, Ont., westward. At the end of this gap begins the Hydro Electric Power System of Ontario, which system extends from this point to Windsor, Ont., just opposite Detroit.

Crossing the river into Detroit, lines radiate from Detroit over a considerable area in the State of Michigan. Thus, with the exception of one gap, which no doubt will be closed within a year or two, a continuous transmission line extends from the City of Quebec, westward to Detroit, Michigan.

In the same manner a line extends southward from Shawinigan Falls, crossing the St. Lawrence River at Three Rivers, and extending in a general southerly direction to Sherbrooke, Que. From this point lines owned by the Southern Canada Power Company extend with short gaps at the present time across the international boundary line into northern Vermont. There is a gap here of a few miles, and then commences the system of the Connecticut River & Power Company and its allied companies, which extend continuously southward through Vermont, to Worcester, Mass., and eastward to Providence, and I believe connections are made at the present time into Boston, Mass.

Thus even at the present time, with small transmission lines it is true, important points such as Quebc, Montreal, Toronto, Detroit, Worcester, Mass., and Providence, R. I. are within a measurable distance of being on an inter-connected network.

There are other examples, such as those shown by the Southern Power Company, and by some of the California companies, illustrating in the same way the gradual linking up of individual systems, and the great extent of the lines.

In the outline given above, of the three main types of transmission lines, I have referred to the first as a steel tower line carrying two circuits.

This has become common practice because the cost of right-of-way and the cost of the supporting structure is to a considerable extent independent of the number of circuits. It is, however, more economical to build a steel tower structure carrying two circuits, than to

*Vice-Pres. & Chief Engr., Shawinigan Water & Power Co., Montreal, Can.

ALUMNI SEE PAGE 191

carry two separate circuits each on its own set of towers.

With the adoption of 60-cycles as the standard frequency the voltage of these steel tower lines has been established at about 100,000 volts and upwards. At this voltage power can be transmitted 100 miles in units of about 25,000 kilowatts per circuit under favorable financial conditions, Such a line built previous to the increase of prices due to the war, would cost roughly $10,000 per mile or $1,000,000 for a line 100 miles long. With a capacity for transmitting 50,000 kilowatts, the investment per kilowatt would be $40.

Such main trunk lines as above described have been made possible through the development of the suspension type of insulator. When this type of insulator was first adopted, it was considered probable that the insulator problem had been largely solved. A few years experience with these insulators however, developed a new set of problems which have as yet been only partially solved. I refer to the fact that the suspension type insulator does not give a rigid support to the conductor, and that whenever the loading at adjacent spans, usually caused by sleet, is unequal, the sags vary, and short circuits are liable to result. To meet this problem the centre cross arm of this type of construction is usually projected beyond the other two, and the arrangement of the wires is not in a vertical plane, but the center wire is from 5′ to 10′ outside the plane of the others.

Another method of meeting the difficulty of non-rigid supports, is to use a bimetallic wire consisting of a steel core of very high tensile strength surrounded by aluminum or copper conductor. With such an arrangement the sag can be reduced very considerably, and the liability of trouble from this cause therefore decreased.

One of the unexpected benefits from the use of suspension insulators, has been the relative immunity from lightning disturbances on these very high voltage lines.

With lines operating above 100,000 volts and insulated against flashovers up to 500,000 volts, the trouble from lightning seems to be materially decreased. The experience seems to be that a large percentage of the lightning disturbances which reach transmission lines, are of lower order than 500,000 volts, and therefore the insulation of these main trunk lines has reached a point where a very considerable percentage of the lightning disturbances which affect lower voltage lines, do not break down the insulation of these main lines.

The second group in which I have divided the transmission lines consist of latticed steel poles or wood poles, carrying, in the case of steel poles, usually two circuits, and in the case of wood poles a single circuit, with voltages up to about 66,000 volts. When voltages are used at the lower limit, about 30,000 volts wood poles are normally used with two circuits. A steel pole line with two circuits capable of delivering about 20,000 H.P. at a distance of 50 miles, can be constructed for about $5,000 per mile, using the same unit price as we referred to under the tower line construction. Such a line would be constructed with large pin type insulators, and operated at about 66,000 volts. On a basis of fifty miles this total cost would be $250,000, and on a basis of 15,000 kilowatts, its unit cost would be about $16.50 per KW. A wood pole line with a single circuit having a capacity of about half of the steel line could be constructed for about $3000 per mile.

The third and last group referred to, consists of lines for transmitting relatively large amounts of power over distances ranging from one to five miles. Some years ago this problem was met by using generators developing in the neighborhood of 10,000 volts. This practice seems to be decreasing, however, and the standard generator voltage to-day has dropped to about 6600 volts for large machines.

As the amounts to be delivered to electrochemical and other works increased up to 50,000 kilowatts, it became evident that the transmission voltage must be raised, and the ordinary practice to-day is to step up from generator voltage to a voltage of about 25,000 as the maximum and about 12,000 as the minimum, and carry this power over two circuits on a steel or wood pole construction, and then reduce this voltage in the customers premises to whatever voltage the customer requires for his business, in the case of electric furnaces to a voltage of around 100 volts. This use of the higher voltage is of course the economic thing, when one considers that the customer in any case must have transformers, and that the cost of transformers at 25,000 volts is not much in excess of the same transformers at lower voltage.

In general, the principle enunciated by Mr. Ralph D Mershon, in his paper read before the International Electrical Congress in St. Louis, has a distinct application in many of the larger problems. Mr. Mershon stated that the larger the amount of power to be transmitted, the further it could be transmitted, because the cost per K. W. of right-of-way, supporting structures, legal and other expenses, insulators, and in fact most of the elements that go to make up the cost of the system exclusive of conductors, was some inverse function of the amount of power. It is therefore evident that from a point of view of economics, it would be easier to work out a problem involving the delivery of 50,000 kilowatts over a transmission line 200 miles long, than one involving the delivery of half that amount of power.

INSULATORS:

I have already referred to the suspension insulator. During the last several years, comparatively few changes have been made on the pin type insulator other than improvements in the quality of the porcelain of which it is constructed. With the continued operation of a large number of transmission lines, and the more careful attention to the performance of insulators, the defects in insulators have become better known and these problems are at the moment the ones which

are receiving the most attention from transmission line engineers. Professor Harris J. Ryan, formerly professor of electrical engineering of Cornell University, has done a great deal of pioneer work on this subject, and is considered one of the best authorities on the performance of insulator porcelain.

The use of porcelain as an insulating material started many years ago, when it became evident that glass could not be used satisfactorily. The main reasons why glass could not be used have been due to its lack of strength its relatively high temperature coefficient and the fact that the method of manufacture makes the glass difficult to anneal properly, and therefore cracks are very liable to develop. The surface of a glass insulator also has never been quite as satisfactory as porcelain. Porcelain or chinaware has been an article of commerce, and has been manufactured for many thousands of years. In the early days of insulator manufacture it was thought that the experience gained in the past was such that little difficulty would be experienced in the manufacture of insulator material.

This proved more or less true in the making of small insulators, and for relative low voltages, say less than 20,000 volts. As the size of the insulator increased, and the mechanical stresses also increased, the difficulty of making satisfactory porcelain became very pronounced. The makers of porcelain then commenced to endeavor to improve the quality, and for the last several years this has been one of the great problems which the porcelain manufacturers have sought to solve. Recent studies of the causes of failures of porcelain insulators show that the success of the lower voltage insulators was due largely to the fact that the porcelain in such insulators acted largely as a spacing material and that little use was made of the porcelain as a real insulator. Then too, the sizes of these insulators were smaller, and it was easier to obtain thorough vitrification of the material. As the voltage increased, and the size of the insulators increased, it soon became evident that some sort of progressive deterioration took place in service. At the present time it is generally believed that this deterioration is largely due to the presence of moisture in the minute fissures of the material; porcelain, owing to its method of manufacture, is somewhat similar to a concrete aggregate, that is, it consists of a large number of particles which are held together by a bonding material. Due to the effect of temperature changes, and possibly to the effect of expansion of the cement with which the sections of porcelain are fastened together, these minute cracks gradually develop throughout the body of the porcelain, until finally moisture is absorbed and a path through the insulator is the result.

While the evidence is not altogether clear at the present time, it seems to be a fair statement that the life of all large insulators is to a large extent independent of the electrical stresses—that is, that insulators mounted outdoors, subject to the same mechanical and thermal stresses, would develop faults, whether they were subject to the voltage stresses of the line or not.

As previously stated, very considerable improvements have been made in the manufacture of porcelain, and the insulators which are manufactured to-day are vastly superior to those made ten years ago. Notwithstanding this fact, there is a strong feeling among electrical engineers, expert on this subject, that porcelain as a material has certain fundamental qualities which are liable to render it unsatisfactory. A search is now being made to find some other material having proper chemical, mechanical and electrical properties. Such a material would have to conform to specifications somewhat as follows:

As regards its chemical qualities it should if possible be simple in its chemical composition; the simpler the better. It should be unaffected by moisture and by the action of the atmosphere, including such effects as may be due to carbon dioxide and water vapor in the air. It should be unaffected by weak acids which may be produced in the air or by the corona action which undoubtedly takes place in those sections of the insulators which are subject to very high dielectric stresses.

As regards the mechanical qualities, it should have at least the mechanical strength of porcelain: it should possess low expansion co-efficient, should be hard, and if possible, not brittle.

As regards its electrical characteristics, it should have a dielectric strength equal to that of porcelain. Such a substance should be homeogenous, i.e. it should consist throughout of one chemical substance, instead of being an aggregation bound together by another substance acting as a bond as is the case with porcelain or concrete.

Various materials have been suggested for this purpose, and the writer for a number of years has advocated the possible use of fused quartz, $Si\ O_2$. It is very interesting to note that this material has also been favorably considered by other engineers acting independently, and that this material has now been suggested to the American Institute of Electrical Engineers as a possible substitute for porcelain in the manufacture of high grade insulators. To be a successful material, the cost must be considered. Porcelain insulators to-day vary in price from 20 cents per pound down to five or six cents per pound, and a satisfactory material to be used as a substitute should not exceed the upper limit of these figures if possible. Very little knowledge is yet available as regards the characteristics of silica in this shape, but it does possess most of the characteristics desired. The great objection to its use at the present time is the difficulty of manufacture. This, however, is a problem that does not seem to be impossible of solution, and it may well be that within the next few years a method will be developed by which this material can be easily manufactured. It seems probable that by the addition of small amounts of one or more other materials to pure $Si\ O_2$ its fusing point can be reduced, and the difficulty that now exists of obtaining the fused mass can be

overcome. The addition of such other materials must not injuriously affect the characteristics of the insulators.

The present practice then for transmission lines on an ideal system would consist of one or more steel tower lines each having two circuits operating at voltages between 100,000 and 175,000 volts. Paralleling such a line would be (in the case of high grade service) a latticed steel pole line operating at 66,000 volts. The transformers would be connected between the main trunk line and the 66,000 volt line at points about 50 miles apart. The 66,000 volt line would be used for the purpose of distributing the power and, whenever necessary, transformers would reduce the 66,000 volts to a lower voltage, either 2200 volts for distribution in the immediate neighborhood of the substation, or to 25,000 volts or 12,500 volts as in the case of small branch lines extending a distance of 25 miles on either side of the branch lines.

The increased price of coal, if maintained for any considerable period after the war, will result in extending the length of economical transmission.

It seems probable at the present time that transmission lines, like water power stations, have already reached close to their possible development along the present lines. While there are many problems yet to be solved to insure the reliability of transmission it does not seem likely that the solution of these problems will materially decrease the cost of the lines.

Some radical changes in the design may be made, by which very much higher voltages can be used, and by which the number of conductors per circuit may possibly be reduced. If this can be successfully accomplished the cost of the transmission will be lowered and the expenses of right-of-way and supporting structures can then be decreased.

We may look forward to a large development in the transmission line field, however, and, as stated previously, the whole country will before many years be covered by main transmission lines and distribution networks, various systems being tied together and supplied with energy from waterpower plants and from steam stations at advantageous points.

THE SWITCHBOARD

JOHN W. UPP, '89*

While an engineer is by temperament and training a man who exercises more than ordinary care and judgment in arriving at a result, he frequently does not apply sufficiently descriptive names to the apparatus and devices which he develops. One reason is that he is far more concerned with what a thing will do, than by the name to call it. Another, and perhaps more important reason is that it is extremely difficult to give a descriptive name to many engineering designs until their field of application has been fully developed.

The word "**Switchboard**" falls in th s latter class. And it is not surprising that the name does not convey its full import when even those who have exact ideas on engineering definitions differ from each other as to its meaning. We read, for example, that "A switchboard, is an apparatus consisting of panels, as of wood, or marble, bearing a collection of switches so arranged that a number of circuits may be connected or combined The apparatus may also have measuring instruments, pilot lights, etc." Another expert writes: "A switchboard consists of instruments, meters and controlling devices necessary for the proper protection and measuring of electrical circuits, assembled in a convenient and symmetrical manner on an insulating and supporting structure."

These definitions are fairly accurate as far as they go, but they cover only a limited part of modern switchboard application and do not take into consideration the most important switchboard apparatus with which we have to deal. The work used abroad is much more comprehensive. There they refer to our "Switchboards" as "Switchgear" and define this word as "The control boards, measuring instruments, protective devices and switches which are used in the operation and control of a complete installation."

Switchboard practice is so comprehensive and has to do with such a multiplicity of electrical appliances that to really attempt to illustrate it in more than the most casual manner would require perhaps more than the entire contents of this issue of THE JOURNAL. We must, therefore, no matter how reluctantly, content ourselves with brief mention of a few features which seem of interest.

The development of switchboard or switchgear practice is covered entirely in the history of the last thirty years. In 1887 a switchboard was a very different piece of apparatus than it is at the present time; then a collection of open knife switches mounted on the smooth side of a pine board and fastened to the wall, were commonly used for low voltage D. C. systems. Instruments and meters were generally unreliable; and automatic protection had been given very little, if any, consideration, except on D. C. arc machines. The next step in switchboard construction is found in the same type of switches mounted on the front of a cabinet with the wires carried on the back and brought through to the switches and indicating devices mounted on the front. This practice is well illustrated in Fig. 1, a switchboard of 1885. Then followed skeleton switchboards, having switches and instruments attached to open

*Manager, Switchboard Department, General Electric Co.

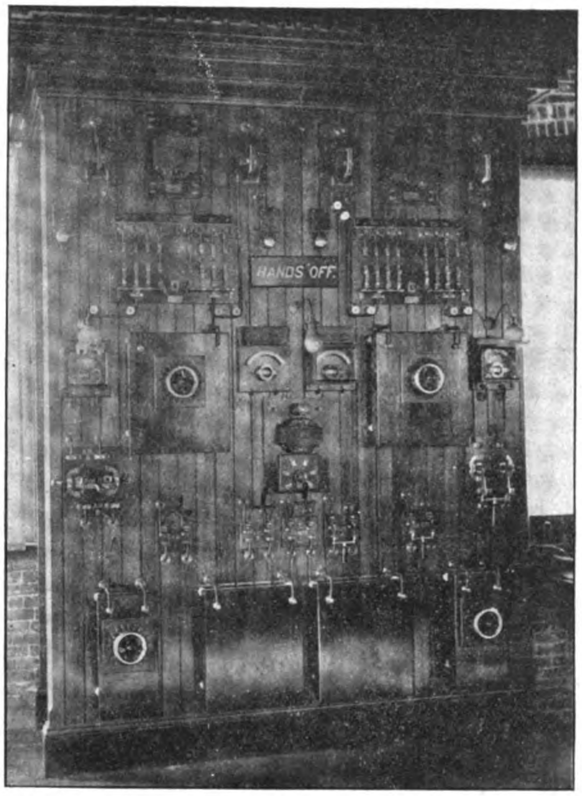


FIG. 1. Early Alternating Current Switchboard.

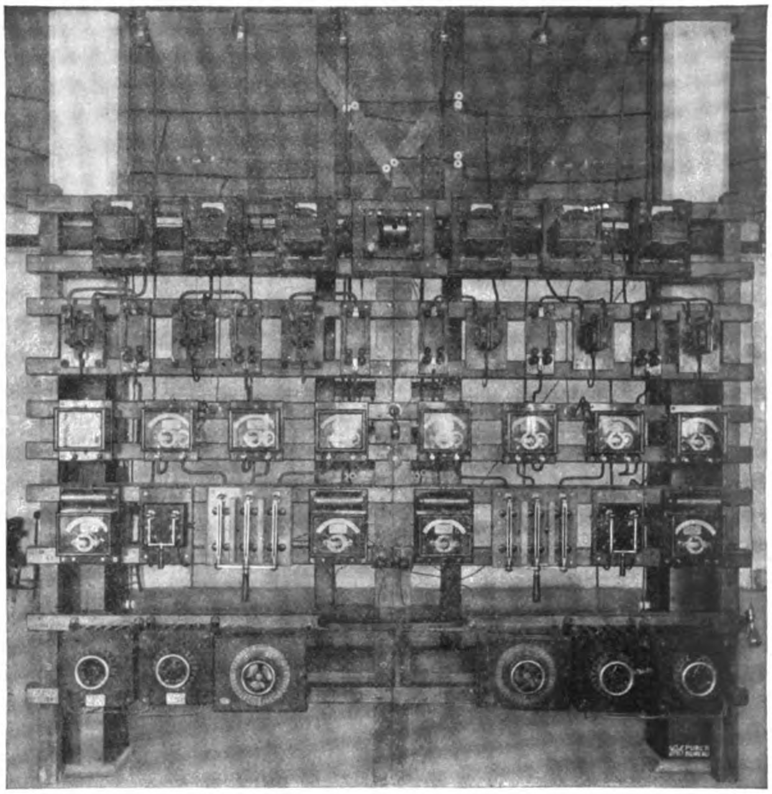


FIG. 2. An Improved Type of Switchboard, similar to the one shown in Fig. 1.

frame-work, these, being regarded as a sort of necessary evil, were usually located in some out-of-the-way corner. Little thought was given to safety or protection; automatic overload of machines was obtained by open link fuses. That the fire risk was high, can be well understood by referring to Fig. 2, a typical switchboard of 1890.

We find that the next step in development consists of an attempt to make the switchboard fireproof, as there had been many very disastrous experiences with switchboards of the cabinet or rack type. Fig. 3 shows one of the earliest forms of fire-proof construction. This switchboard was in use until 1908 when it was replaced by a switchboard of modern type.

Between 1890 and 1895 the first efforts were made to develop the modern type of control switchboard. Slate, marble and soapstone were found to have the proper mechanical and electrical characteristics, but slate, on account of its relative cheapness, was adopted for general use, marble being specified only for those installations where extra precautions were thought necessary to protect the operators, or for decorative purposes. It was not long after the fireproof switch-

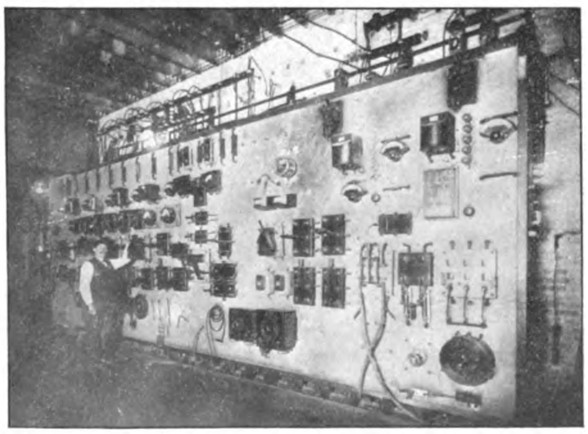


FIG. 3. Brick Switchboard.

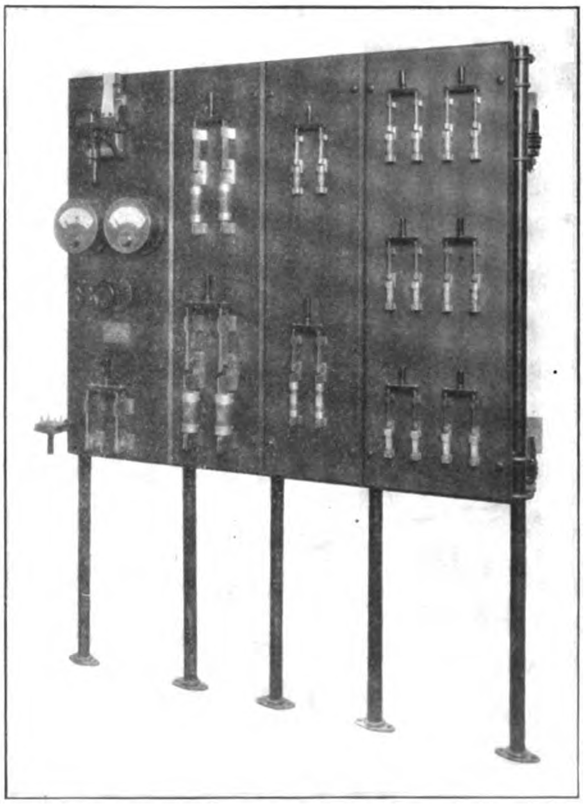


FIG. 4. Small Plant Direct Current Generator and Feeder Switchboard.

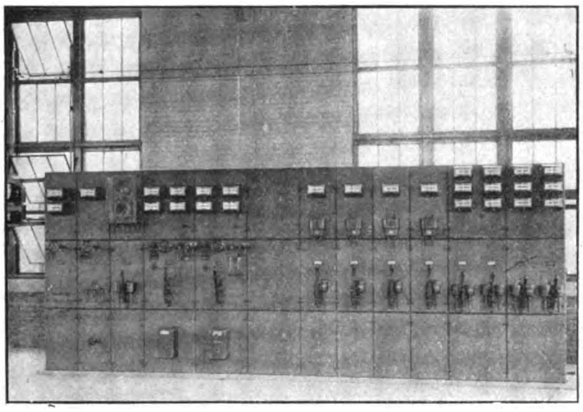


Fig. 5. Modern Switchboard.

board came into use that there was standardization of panel construction, and the effect of standardization is now found in the standard unit panels of the present day. Fig. 4 illustrates one of the simplest, but most commonly used type of switchboards for a small direct current plant. A switchboard for a medium size alternating current station is shown in Fig. 5.

Figs. 6 and 7 show a control board and switch gallery

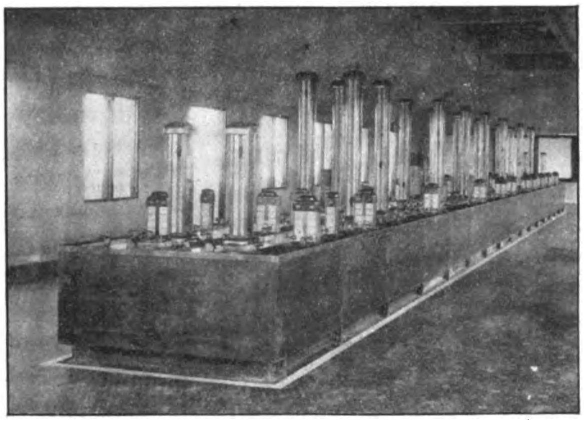


Fig. 8. Centralized Control Board for Remote Control of Lock Machinery, Typical of all Locks, Panama Canal.

which together make a complete switchboard installation in one of our modern central stations. This switchboard is no "after-thought" in station construction. It received the same careful engineering consideration when the station was designed as the generators, turbines, and other apparatus. The control board is located in the most convenient position for operation and inspection and with the operator at its front, performs the same function for the installation that the brain does for the human body,—it governs all portions of the equipment. From the switchboard, the opening and closing of the generator and feeder circuit breakers are controlled, the power is measured, the load adjusted and, by protective devices, the destructive effects of short circuits avoided—a single operator having within his reach devices which enable him to meet every condition of service or emergency.

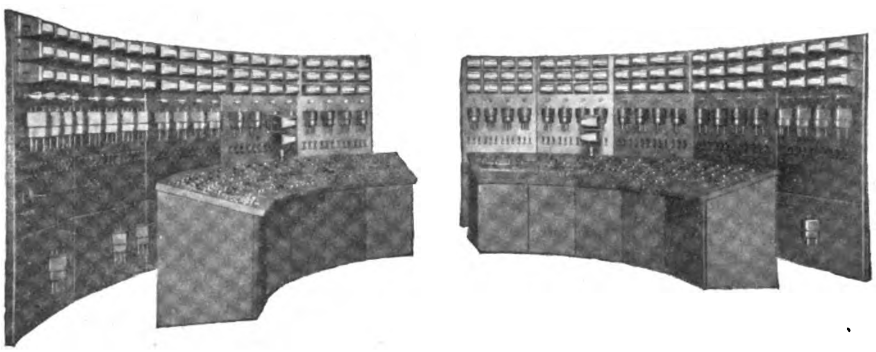


Fig. 6. Altnerating Current Switchboard to Control 20–13000 Volt 25-Cycle and 20-13000 Volt 60-Cycle Feeder Circuits.

The safety of the operator and station attendants is always given first consideration in a modern layout, and as far as possible, by means of interlocking, the sequence of events in opening or closing of circuits is predetermined. The greatest length to which this latter construction has been carried is illustrated by that form of control board, Fig. 8 used for the operation of the

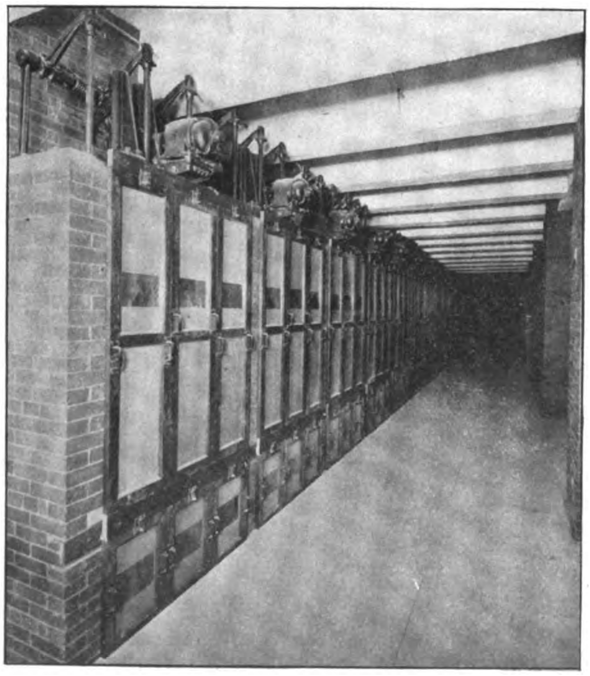


Fig. 7. Section of Oil Circuit Breaker.

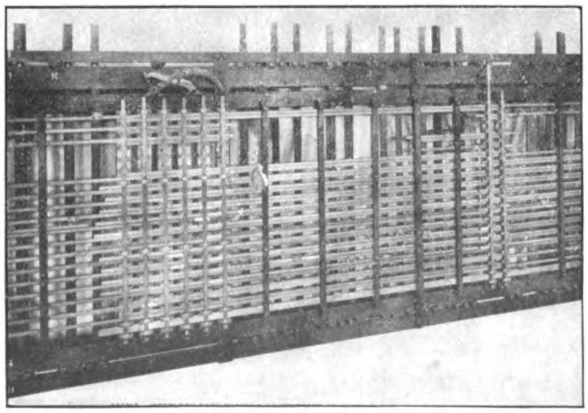


Fig. 9. Interlock Rack for Control Board.

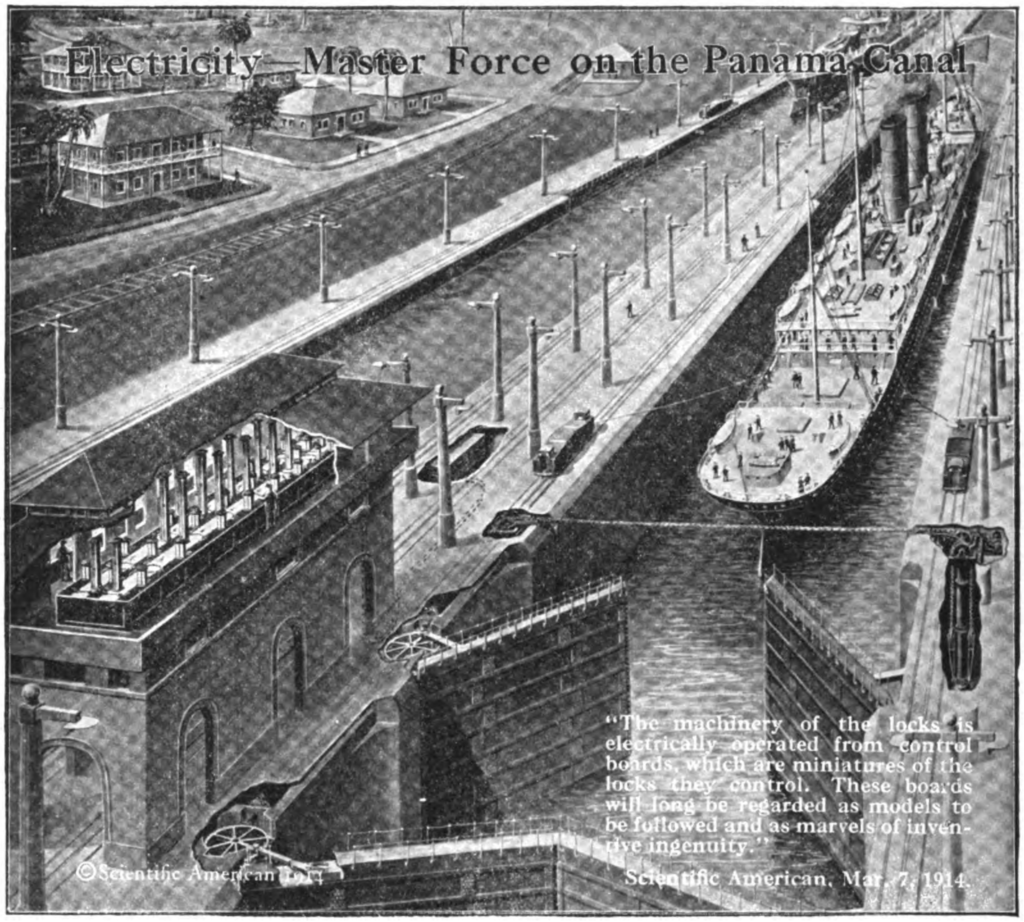


FIG. 10. Panama Canal Locks Showing Centralized Control Board for Operating Locks, and Electric Locomotives Towing Ships Through.

Panama Canal where a switchboard operator, in one case a mile from the device which is to be operated, controls and regulates the gates, valves and other appliances used in the lock construction. One section of an interlocking rack, located underneath the control board, which insures that the various control devices will be operated in their proper sequence, is shown in Fig. 9. Fig. 10 shows the location of the control board as related to the canal locks.

While it is evident that the operator is protected from accidental contact with dangerous voltages when the operating board is located some distance from the apparatus controlled, no less is an attempt made to pro-

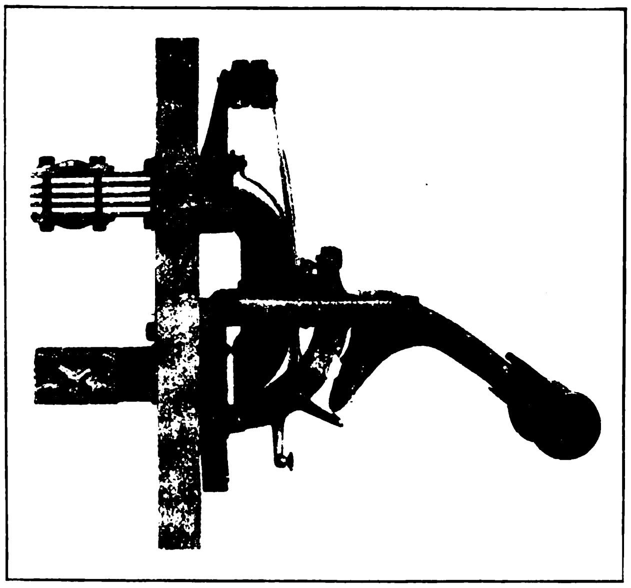


FIG. 11. Automatic Air Circuit Breaker with Laminated Studs and Insulating Handles. 4000 Amp.

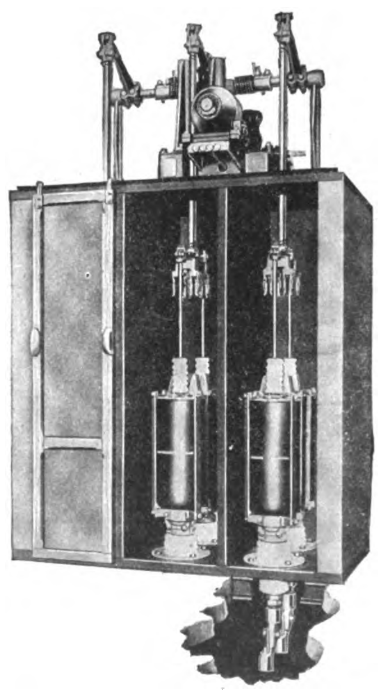


FIG. 12. 15000 Volt 1200 Amp. Triple Pole Single Throw Oil Circuit Breaker.

tect him in those installations which do not warrant such expensive construction.

A modern air circuit breaker for D. C. and low voltage A. C. work is shown in Fig. 11. Apparatus of this character is designed to operate under conditions

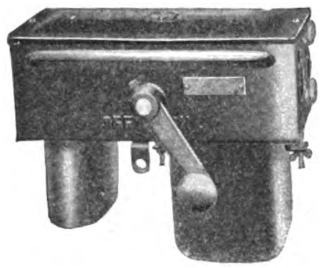


FIG. 13. Industrial Oil Circuit Breaker with Double Series Inverse Time Limit Trip.

of overload, underload, low voltage, reverse current and performs its functions with regularity and satisfaction.

Oil circuit breakers for the control of the high capacity modern stations are well illustrated in Fig. 12 and

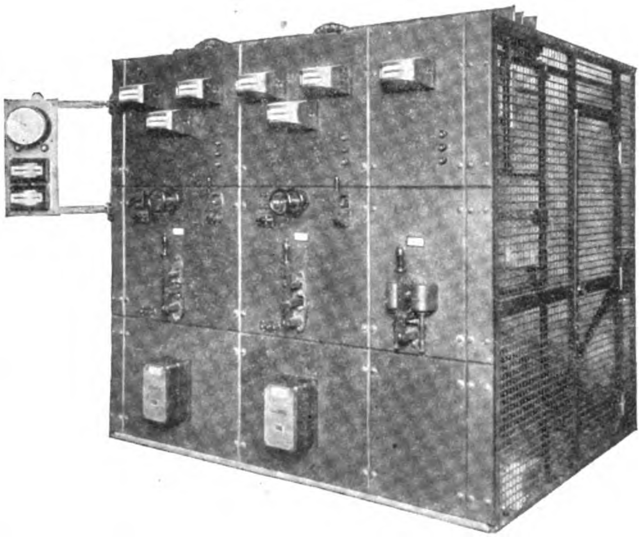


FIG. 14. Dead Front Safety-First A. C. Switchboard. 2300 V. 3-Phase.

those of small size that can be mounted on machine tools and industrial machines in Fig. 13.

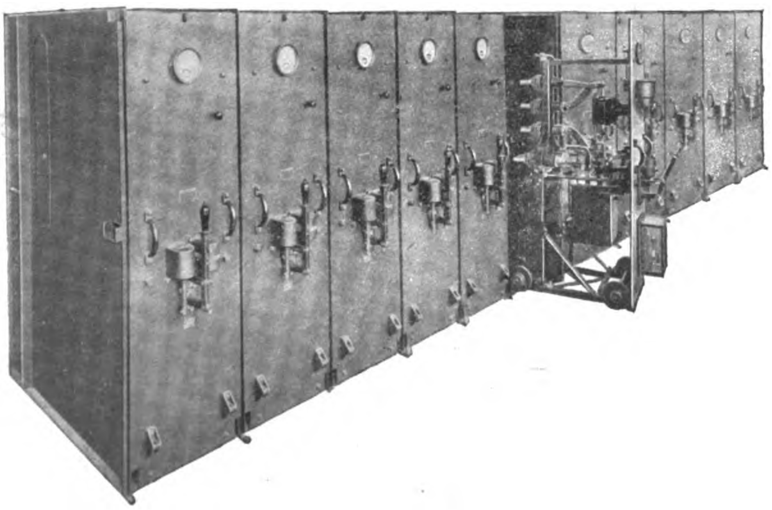


FIG. 15. Removable Truck Safety-First Switchboard.

In Fig. 14 is shown a modern 2300 volt A. C. switchboard with the back fully guarded, and in Fig. 15 the latest development in protected station switchboards. In this latter construction there is complete protection against accidental contact. In order to inspect or re-

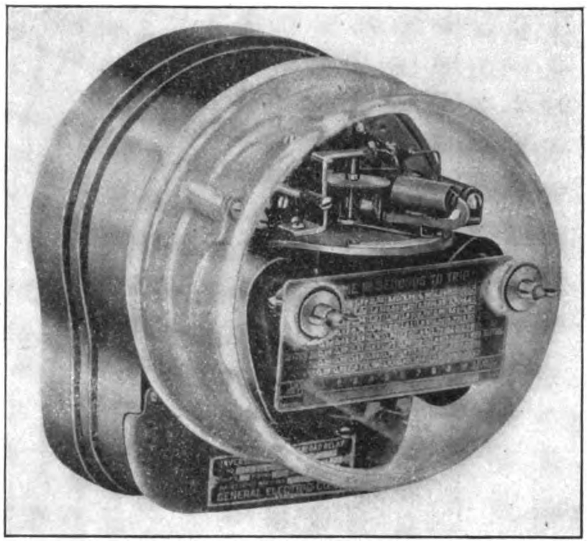


FIG. 16. Type I Form A, Inverse Time Limit Overload Relay.

pair any of the circuit breakers or high voltage devices it is necessary to remove the panel unit which, as shown, is conveniently mounted on trucks and so arranged that the opening device must be in proper position be-

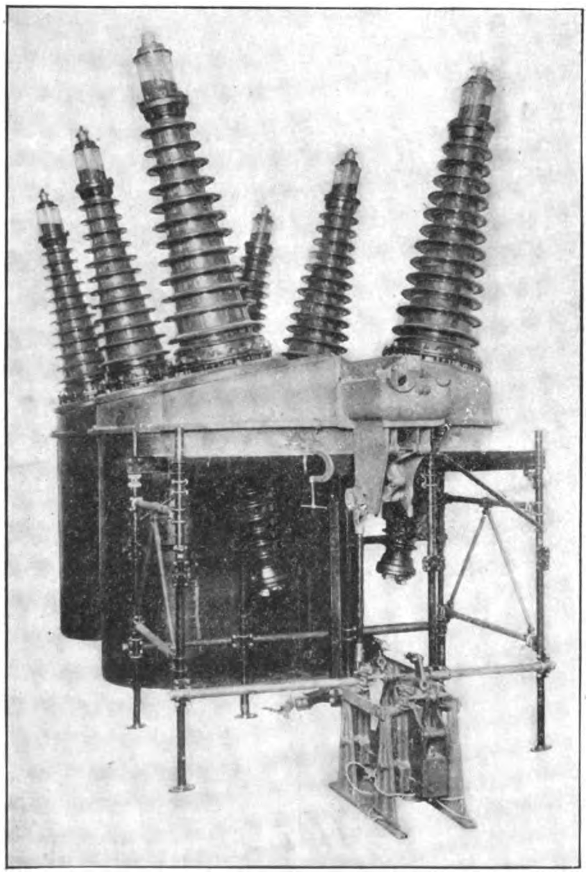


FIG. 17. Type F Form KO-37 135,000 V. Oil Circuit Breaker, with High Altitude Standard Bushings and with Weatherproof Covers Removed and 1st Unit supported on framework to show interior.

fore this unit can be removed from the switch board installation.

In the complex interconnected systems of to-day, it is necessary for satisfactory service, to use sensitive automatic instruments which under regular operating conditions will connect or disconnect certain lines of apparatus to or from the electrical system as required. One device for this purpose, shown in Fig. 16, operates with almost human intelligence. If a feeder becomes over-loaded, additional generating capacity will be thrown in or the line disconnected as predetermined. Automatically, one circuit or another will be selected for service, or in case of emergency conditions, faulty lines will be picked out and disconnected in succession and later restored to operating conditions as soon as the fault is removed. Without the modern relay, the operation of important installations could only be carried on with difficulty and frequent interruption of service.

On systems of 45,000 to 200,000 volts, much of the apparatus is now placed outdoors but controlled from the control board in the station. An outdoor oil circuit breaker and an outdoor substation are illustrated in Fig. 17 and 18.

Before taking leave of the subject of switchboard practice, I wish to emphasize this point. The Switchboard Designing Engineer does not confine himself to the development of slate and marble panels on which simple switching and indicating devices are to be mounted. His field covers the design of measuring instruments, of relays, switches, air and oil circuit breakers, and numerous other related protective and indicating devices for the control and distribution of power in stations of every character and size.

The problems of switchboard practice solved to-day lead but to new problems of to-morrow. Machines grow in size as fast as they can be controlled; voltages of transmission lines increase as rapidly as devices can be designed to protect them.

The application of automatic devices; the never ending changing conditions, all present a most fascinating and worthy study, a work which will tax to the utmost the ingenuity and ability of the most broadly educated and highest type of Engineer, and also give unusual opportunity to those young engineers who are interested in electrical problems, and in the control, operation, and protection of the up-to-date central station.

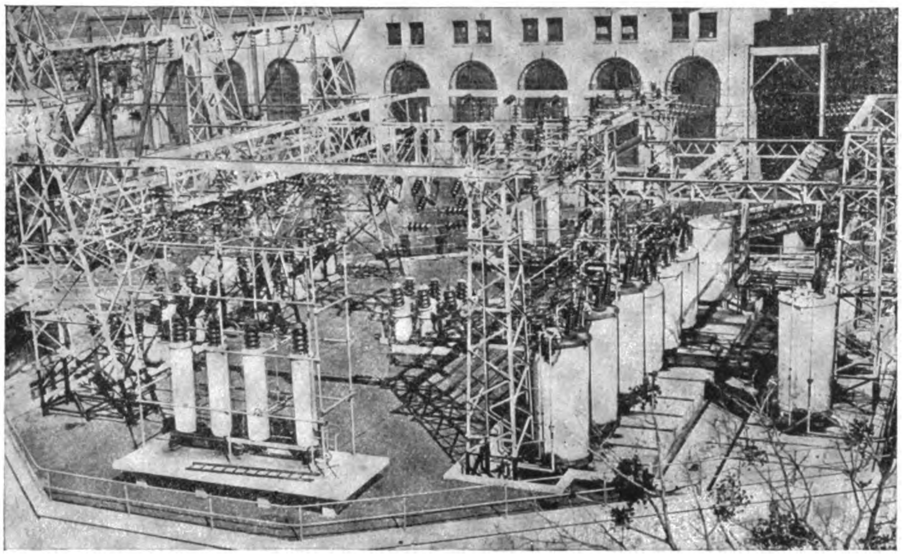


Fig. 18. Outdoor Sub-Station 60,000/2400 V. Ft. Worth Power and Light Company, Ft. Worth, Texas.

TELEPHONE TRANSMISSION

BRANCROFT GHERARDI, '93*

The purpose of a telephone system is to enable people to communicate with each other by spoken words when located at a distance from each other. The only practicable means now known of accomplishing this is by electricity. Problems concerning telephone transmission except some of those pertaining to the transmitter and the receiver are, therefore, problems relating to the transmission of electrical energy. Broadly speaking, these problems bear a general resemblance to the problems pertaining to alternating current power transmission, but both qualitatively and quantitatively there are many important differences. The electric current which carries a telephone message is an alternating current consisting of many different frequencies and varying in a most complex manner. To successfully transmit this current we must accomplish the following results. It must be

*Engineer of Plant, American Telephone and Telegraph Company.

transmitted with a reasonable degree of efficiency so that the amount of received energy will be sufficient to satisfactorily operate the telephone receiver. It must be transmitted not only with efficiency as a whole, but each of its component parts, which may be of frequencies from about 200 periods a second to over 2000 periods a second, must be transmitted with a sufficiently uniform degree of efficiency so that the character of the wave will not be unduly distorted. In addition the wave must be protected from electrical disturbances induced into the circuits from outside sources. These results must be attained not only with reference to the line wires and the apparatus directly associated with them, but also with reference to the switchboards necessary for inter-connection, the signalling apparatus necessary to control the use of the circuits and the protective apparatus necessary to safeguard the users of the circuits and the circuits themselves and their associated apparatus against excessive electrical currents or potentials.

In order to illustrate the nature of some of these problems I will first consider a comparatively long toll line in which many of them arise in an acute form.

A New York-San Francisco circuit or rather the circuits which combined together constitute a New York-San Francisco circuit are representative of many telephone circuits which together form a network connecting the principal centers in the United States. The distance from New York to San Francisco is 3,400 miles. The circuit in question consists of two wires each weighing 435 pounds to the mile or a total of about 3,000,000 pounds of copper. A circuit such as this for the telephone current having an average frequency of 800 p. p. s. would deliver at the receiving end one fifty billionth of the energy put in it at the transmitting end. Certain limitations on the power of telephone transmitters and the sensitiveness of telephone receivers, which will be referred to later, establish the fact that it is not reasonable to expect good transmission on a line which does not deliver to the telephone receiver at least one thousandth of the energy sent out by the transmitter and in many cases one one-hundredth or more is desirable.

These facts are sufficient to show that the long distance telephone problem is largely a line problem. One step in improving the efficiency of a long line is to add to it at suitably determined intervals specially designed inductance coils known as loading coils. On the New York-San Francisco line there are about 400 such coils spaced at intervals of about eight miles. These coils diminish the losses in the circuit to such an extent that it will deliver at the receiving end about one-millionth of the energy put in the circuit at the transmitting end. This proportion of received energy is still far below that needed for commercial service.

A step has, however, been accomplished in the right direction, but only by the most careful design and manufacture and spacing of the loading coils. Because these loading coils occur successively in the line any loses in them are cumulative and as every inductance coil must have losses both in its conductor and in its core these must be carefully studied. An apparently insignificant loss of only one per cent of the energy in each loading coil would mean that the received energy would be less than two per cent of what it would have been had there been no losses in the coils. Actually on this circuit, the loss in the coils reduces the received energy to about one-quarter of what it would have been had the coils been without energy losses. Practically these coils are as good as it is proper to make them with the existing state of the art and considering the economics of the problem.

Further improvements have been made by associating with this line intermediate apparatus known as telephone repeaters and capable of receiving an enfeebled electric current and putting into the line a new electric current derived from a separate source of energy and controlled by the enfeebled received electric current, so that the new current possesses the same characteristics in regard to shape but is greatly magnified. The use of such apparatus required a comprehensive study of amplifiers, methods of connecting them into the circuit and of line characteristics, and many rearrangements in the existing lines so as to adapt them to the new methods of working. Thus it is possible to receive at the distant end of the circuit energy equal to one-eightieth of that placed upon the circuit at the transmitting end and thereby give good commercial service.

There are many other problems in connection with this line which cannot be touched upon within the limits of a paper such as this but a few may be mentioned. This line is equipped with about 300,000 insulators. Loss of energy must be guarded against at each of these points. For various reasons it is necessary to insert in this line a number of transformers, or as they are usually called by telephone men repeating coils. To properly handle the high frequency telephone currents and to make from time to time the necessary changes in impedance, that is the ratio of voltage to current, the telephone transformer problem has been carefully worked out so that there are available for use suitable transformers of high efficiency. To meet the practicable operating conditions and to enable the line to be used, not only at its terminals, but from intermediate points, the line is switched at a number of points where it passes through telephone switchboards. At each of these points the switchboard apparatus must be designed with the utmost care to reduce the losses to a minimum. At numerous other points the line must be made available for testing and similar conditions must be met.

Under many conditions it is necessary to place telephone lines in cable. Since this brings the two wires constituting a circuit close to each other and requires that some dielectric other than air be used for maintaining the separation of the wires, the transmission losses are much greater than in the open wire circuits. Further limitations result from the fact that as a cable of this type usually employed must

be encased in a lead sheath and either supported by a strand or placed in an underground duct, there are sharper economic limits to the sizes of wire that may be employed. At the present time there is working in the plant of the Bell Telephone System a cable almost 500 miles long extending between Boston and Washington and connecting these places together and with New York and Philadelphia and other important places. The largest size of wire employed in this cable is a No. 10 B. & S. gauge and with this the following results are obtained: Without loading, one thirty thousand billionth of the energy at the sending end is received. By suitable loading, the efficiency of the circuit is increased so that one three hundredth of the energy is received. By the addition of suitably connected amplifiers or repeaters the efficiency of this circuit 500 miles long is rendered such that one-tenth of the transmitted energy is received or a very high grade of telephone transmission is given. These results are obtained, however, only by most careful and scientific attention to the design of the cable itself, the design of the loading coils, the design of the repeaters and associated apparatus, and all of the switchboard and other apparatus connected to the circuit.

In connection with such circuits as these it is interesting to note that they are relatively long in comparison with the electrical waves which they carry. On this circuit of which we have now been speaking the wave length for 800 frequency is about 13 miles. On such a circuit we are dealing with a decided case of wave propagation, the receiving apparatus being electrically so far distant from the transmitting apparatus that it exercises no perceptible reaction on it. This is likewise true of long open wire circuits.

Many long telephone circuits are arranged for what is known as phantom circuit working, by which out of two ordinary metallic circuits a third one may be obtained by using the two wires of one circuit in parallel as one side of the phantom circuit and the two wires of the other circuit in parallel as the other side of the phantom circuit. To accomplish this result it is necessary to make arrangements at the terminals so as to connect in at exactly the middle point electrically of each of the two circuits. This is usually done by means of carefully balanced transformers, the phantom circuit connection being made at the middle point of one winding. It is also necessary to carefully arrange the wires of the circuits with reference to each other so that there is no crosstalk either between the side circuits or between either side circuit and the derived phantom circuit. The balancing problems in connection with such arrangements are complex and have received long study.

In addition, in many cases each wire is used as a grounded circuit for telegraphy. This necessitates the use of carefully designed apparatus usually consisting of condensers and impedance coils so arranged as to separate the telephone current and the lower frequency telegraph current from each other. This must be done so perfectly that neither service will be interfered with either by the presence of the other or by the losses brought in by the separating apparatus.

Since the telephone receiver is so sensitive it is necessary that arrangements shall be made so that there will not be induced upon the telephone circuit even minute currents from outside sources. Such disturbances are of two general classes:

The first is that which may arise from the induction between one telephone circuit and another. Practical considerations make it necessary to place a number of open wire circuits on the same pole line, and in cables circuits are necessarily brought in very close proximity to each other. There may be as many as 40 or 50 open wire circuits on the same pole line, and often as many as 1200 pairs of wire are placed in a single underground cable. This induction between telephone circuits is commonly called crosstalk.

So sensitive is the telephone that if there is transmitted from one circuit to another more than one-millionth of the energy of the telephone current in the transmitting circuit it is likely to produce objectionable crosstalk. To avoid this it has been necessary not only to most carefully arrange the telephone circuits themselves so that they will be balanced but to rigorously consider the design and method of connection of each piece of apparatus associated with the talking circuit. Every loading coil, transformer, relay and condenser must be considered, not only with due regard to its effect on the balance of the circuit, but also with reference to the possibility of its directly inducing disturbances in adjacent apparatus.

A second class of disturbance that must be guarded against is that arising from electrical circuits rendering other services, of which electric light and power circuits are typical. These circuits carry currents vastly more powerful than the telephone current and are surrounded by electrostatic and electromagnetic fields which may, if suitable precautions are not taken, disturb telephone circuits at distances of hundreds and even thousands of feet. The problem of protecting the telephone circuits, particularly open wire circuits, from such disturbances is one of the greatest magnitude. In many cases it cannot be met merely in the design and arrangement of the telephone circuits. It requires co-operation on the part of the electric light and power people to balance their systems as far as practicable and to so design their generators, motors and other apparatus as to avoid the presence in them of frequencies that seriously interfere with telephone service. This has required much work on the part of not only the telephone engineers, but by the electric light and power engineers. It is interesting to note in this connection that in general it is not the fundamental frequency of the power system which causes the trouble in the telephone circuits, but it is the higher harmonics which are of no value to power people as part of the operation of their system, but which are there because, considering the power problem in isolation, there has not appeared to have been sufficient incentive to remove them.

So far I have spoken of telephone transmission in particular relation to the long distance lines. Important and difficult transmission and economic problems occur in the local plants which include the local subscriber's lines and the telephone instruments themselves, the trunk lines between the various offices in all large cities and the short haul or suburban toll lines. Limitations of space prevent more than a reference to these problems although they are as interesting and at least as important as those occurring in the long lines and must be worked out with due regard to the ability to connect together at any time all of the elements of the system needed to enable any two subscribers wherever located to communicate with each other.

The substation sets, including the transmitter and the receiver, are most important elements of the system. At first view this apparatus seems simple. The transmitter which converts the speech vibrations of the air into the telephone current consists essentially of a diaphragm controlling a group of microphonic contacts. The receiver which converts the received telephone current into air vibrations consists of an electromagnet acting on a diaphragm. Considering the millions of these instruments required and the essential functions which they perform their design evidently justifies the most elaborate and persistent investigation and development work. They have been and are being so treated and although apparently simple, there are to be found in them complex mechanical, thermal and electrical problems which combine somewhat the problems of measuring instruments, generator and motor design as well as other problems peculiar to themselves. There is also required consideration of the nature of speech vibrations, their essential characteristics and the relative importance of the various component vibrations going to make up the complete complex wave forms.

The fundamental design of transmitters and receivers cannot be considered in isolation. Such work must be considered in its relation to the lines and other apparatus, with which the instruments are to be used. Many inventors and scientists in this country and Europe have taken the view that the way to solve the problem of telephony through cables and over long open wire lines was to indefinitely increase the power of the transmitter, losing sight of the fact that such a solution would not only require the use of special and complex apparatus at each subscriber's station but would so increase the crosstalk on telephone circuits as to require the complete reconstruction of existing telephone plants and the construction of additions on a much more expensive and difficult basis, perhaps even on one that could not be successfully maintained in practice. Engineering investigations made on a correct basis, taking into account all of the factors of the case have shown us that a great increase in the power of the transmitter is not the way to solve these problems and we have attacked them along other lines, the nature of which have been briefly indicated.

An indefinite increase in the sensitiveness of the receiver would similarly involve difficulties among which may be mentioned the increased effect of disturbances from outside circuits and from crosstalk.

Every American familiar with the facts must view with satisfaction what has already been accomplished in this country in the development of the telephone and telephony. The Bell Telephone System to-day consisting as it does of about ten million telephone stations and twenty-five million miles of telephone circuit connecting these stations together is generally recognized as the model telephone system of the world. Due to this development of the Bell System there are in the United States to-day more telephones and telephone plants than are to be found in all the rest of the world. Telephony is truly an American art both in its development and in the extent of its application, but as great as these developments have been the engineers of the Bell System do not feel that their work is done, but on the contrary they look forward confidently to advances and developments in the future that will be even greater than those which have been made in the past.

ELECTRIC CONTROL

L. L. TATUM, '97*

The relation of control engineering to the other specialized branches of electrical engineering may be shown by a simile. Control engineering finds its largest field in electric power application rather than power generation, and the machine, the motor, and the contoller, may be compared to the human body. Like the human body, the machine with its individual motor and controller is a unit, a single complete thing, not an aggregation of separate units of different classes or tribes. Like the human body it is made up of various parts. The mechanical devices may be compared to the skeleton and various organs, the muscles to the motive power, and the brain and nervous system to the controlling devices.

The relation of the control engineering specialist to specialists in other lines is that of the nerve doctor to the other branches of medicine and surgery. As the nerve specialist must know not only the normal functions, but also the extremes of possibilities, and the vagaries of disorders, of all the organs and muscles of the patient, so must the control engineer study and know not only the normal functions, but also the extremes of capabilities and the lurking weaknesses of all parts of the machine to be controlled.

*Asst. Chief Engineer, Cutler-Hammer Mfg. Co.

ALUMNI SEE PAGE 191

Even the development of the profession of control engineering can be compared to the development of man. In the primal state the economic functions of man, those which relate to his development into the citizen of to-day, were most simple. He foraged for himself and cared for himself and his immediate family alone. So with the early and scattered motor power application. As civilization developed and community interests arose, man was obliged to adjust himself to the needs and wants of others, laws were made and accepted, and the division of labor specialization began. So with electric power: As distribution systems and factory plants developed, the application of motors to different machines called for the development of rules and codes and of different specialized functions.

As in the modern community of to-day there are various types of men, physically and mentally, so in the power applications there are the various machines, with motors of varying characteristics and control of varying refinements. The maximum productiveness of a community necessitates the selection of the man best fitted physically and mentally for each job. So also the maximum productiveness necessitates the motor with the best inherent characteristics, and the proper control. For the steady, ceaseless grind of the time clerk, a man of patience, accuracy, simplicity of mind and sedentary life is well fitted. The operation of a locomotive crane requires a man of quick thought and action, keen judgment of distance and speed, good physical development under absolute control and the ability to carry short peak loads of work. The aviator must be sensitive to the slightest change of conditions, his mind and muscles must respond instantly and surely, he must be capable of great concentration, but need not sustain the strain for long periods.

Similarly with motor applications. The mine fan requires a motor of absolute reliability, of steady speed, of ability to carry a known and constant load indefinitely without overheating, with control which protects it against external influences and performs its few functions with simplicity. The crane motor and controller must handle occasional heavy overloads, must stand excessive strains and shock, may slow down but must keep on pulling, and may overheat, but the periods of light load and rest permit of cooling and ready repair. The motor on the tension device of a newspaper press, which tightens or loosens the brake of a roll of paper varying from 30 to 10 inches in diameter and running off at 1200 feet per minute, must be extremely sensitive to the indication of delicate control devices and act instantly, but is subject to tender care and adjustment.

The improvements that have been made in industrial productiveness by extreme specialization of man, are of the same order as those obtainable by specialization of machinery and of its motive power and control. The physical types of men and motors are comparatively few. The mental variations of each type are many, and for each job, or each machine there is a best combination. The motor designer produces his few varieties of physical types; the control designer selects the one most capable of training to the need of each job and supplies the nervous system necessary.

Community life has necessitated laws to govern man, so also the development of electric power has necessitated laws. National, state, municipal, and corporation rules or codes must be observed or anarchy in operation and repair would result. Safety to operators and to the innocent, but often curious, public must be maintained. Safety of the apparatus itself and continuity of operation are economic necessities. The codes and rules represent the best compromises of many minds as to how those results can be secured. These are the limitations to freedom of personal action imposed by the growth of community life.

Since the past history of electric motor application, which is synonymous with electric control, has followed the trend of human development, can we not hazard a look into the future, to see along what lines development may be expected?

The dominant factor is the education of the public, and especially of the manufacturer of power driven machinery to the fact that there are various types of motors and controllers. That there are constant speed, and variable speed, and adjustable speed, high inertia and low inertia, constant duty, and intermittent duty, and momentary duty motors, just as men are not simply men, but fat men or thin men, alert or sluggish men, thinking or mechanically acting men. The selection of the right type of motor for his machine, is just as important as the selection of the type of man for his job. The machine manufacturer knows what his machine is intended to do, and should select the motor and controller best suited to accomplish it. He knows its limitations and the protection against exceeding these limitations that must be provided. The development of the proper equipment can be made once, and be duplicated on future machines. If the practice of the past is followed and the machine manufacturer leaves to each purchaser the selection of motor equipment, the development must be made over and over by different people, and with different degrees of success. This is an economic loss. That manufacturer who fails to assume the responsibility for the motor and control equipment of the machine he produces is failing in his duty to the community.

To the control designer this tendency to treat each machine as a complete unit, means the refinement of control for that machine, rather than the use of a simple standard "starter." It means the study of results to be accomplished; often the modification of the machine itself; the selection of, or development of, a motor with best inherent characteristics; and then a control of minimum complexity which will secure the results, protect the motor and the machine, and comply with the rules and laws of the community. This may sound like heresy to the American creed of "Standardization," but it is rather in conformity to it. It is merely a question of the unit to which "Standardization" applies, whether to the machine as a whole, or to the integral parts of it, and since economy and productiveness

demand a refinement of the integral parts to suit the machine, the complete device is the logical unit. The enormous growth of power applications even now permits of good manufacturing conditions in these specialized devices, and with the improved service will come still wider fields of use.

Another important factor in the development of control is the safety first movement. An example of rubber mill practice will illustrate it. In the working of rubber hot rolls are used, into which the sticky rubber must be fed by hand. The power required is of the order of 50 to 100 horse power, and the old form of drive was from a jack shaft by belts. If an operator's hand was caught he was pulled against a safety bar, which threw out a clutch and stopped the jack shaft. The average damage to a man was an arm crushed up to the shoulder. Magnetic clutches on each machine were substituted, with a saving of the upper arm. Adding a magnetically released brake on the machine side of the clutch, to absorb some of the inertia, reduced the damage to the loss of a hand, and the hand was not damaged so much from crushing as from cooking in the hot rolls before the machine could be backed up to release it. The substituted individual motor drive with a control that provides "plugging" of the motor now automatically reverses the roll and throws the hand out of the rolls with only slight skin burns. If the rolls were allowed to run backward the operator would often be carried into the other side of the rolls, but the control provides for only half a revolution of reverse motion and then brings the machine to a standstill.

The necessity of guarding the operator against the possibility of accident from belting and gearing makes mechanical drives more and more difficult and the individual motor, geared directly to the machine, and changing in speed with the machine, offers the best solution. With the individual motor all the refinement of control and of protective devices are at once possible. Next to the guarding of running parts, protection against accidental or unexpected starting is the most important safety feature. While this form of protection has for some years been applied to the larger and more expensive machines, the need of it is even greater on the simple small machines because they are less likely to be operated by skilled and careful attendants. The little household motors, of so small a power as to be held in contempt by the average man, still are capable of crushing fingers. This safety feature can be obtained by having the power switch held closed magnetically so that it will open on failure of voltage from any cause, and either proportioning the holding magnet so that it cannot reclose the power switch, or connecting it through a "maintaining" circuit so that when once opened it is completely de-energized. The simple snap switch now so common on fractional horse power motor devices, fails in this safety feature, and is doomed to go. In its place there will come an enclosed "no voltage release" switch. As yet the size and cost of such a switch limits its use to larger power motors, but the ingenuity of control designers in cheapening the switch, and the willingness of the public to pay the premium for insurance against accidents will in time bring about its universal adoption.

Where "remote" control is used there is no excuse even now for the omission of this feature. Remote control is obtained by using magnetically operated switches. If a snap or knife switch only is used in the pilot circuit, this protection is lost. By using "momentary contact" switches or push buttons, the safety feature can be obtained, and the extra cost is only one more pilot wire, that is a three-wire, instead of a two-wire pilot circuit.

In this connection, attention should be called to this safety feature on "automatic" controlled machines, such as pumps or compressors started automatically according to the condition of the system they supply. The pilot device for such installations is often out of sight from the motor itself, and is liable to function at any moment. Assuming that suitable guards are provided to protect the general public, there is still need of a safety switch at the machine, to protect the inspector or attendant when working on the machine. In the steel industry this feature is now generally covered by having the main switch adapted to be locked open, and providing each inspector with a padlock with his name on it, so that he can lock the power switch open while working on the machinery. On newspaper presses, control stations are placed adjacent to each part of the press that needs attention, with a safety switch in each station. The motor cannot be started until all safety switches are closed, and the corresponding attendant is clear of the machinery. Unfortunately, these precautions are not carried out in a great many lines of machinery, and it is the duty of the control engineer to educate and encourage the public to demand them.

Next in importance in the future development of control engineering is the tendency to protect both the unthinking public and the attendant against accident from electrical shock. The awakening of the public on this subject has taken preliminary form in the National Safety Code, issued by the Bureau of Standards. In some respects the ideals set up by the code are revolutionary, but as they are economically sound they will live and will lead to even more protective devices than anyone dare at present advocate. The general form of such protection is enclosure of live parts, even for voltages not generally considered dangerous to life. Enclosure with doors that must be opened to expose live parts when apparatus is operated, protects the general public, but not the operator who becomes careless with familiarity, and this point will lead to a requirement for enclosure with operating means on the outside of the case. Adding the cost of these additions to the cheaper manual forms of controllers, helps to bridge the gap in cost between them and the constantly simplified and cheapened remote or automatic forms of control, and will greatly increase the use of the latter form. The ease with which no-voltage protection, overload protection, automatic current limit devices, motion limiting devices, and the many other refinements tending to

protection of the motor and the machine, may be added to the automatic forms of control will be a further factor in this change.

The motor designer has not been idle during this development. Motors are appearing which may be safely started by throwing them directly on the line, eliminating the controller entirely. The sizes of these motors are constantly increasing in rated horse power, and it is probable that before long direct current motors up to 5 horse power and alternating current motors up to 25 horse power, which together include a very large percentage of commercial requirements, may be so handled. It is not, however, apparent that the machines on which these motors are used can stand the shock of such handling, so that the control engineer must work out the compromise between simplicity, and the proper and necessary performance of the whole unit. Even in most cases where control is unnecessary from the standpoint of either the motor or the machine, the no-voltage and overload protection will still require the development of simple switch gear giving these features.

The tendency, therefore, is toward the elimination of manual forms of control, toward simple switch gear, enclosed, operated from the outside of the case, and with protective devices that cannot be defeated by any manipulation of the operator, and to automatic forms also enclosed for mechanical protection, operated from a distant point by push buttons, or by enclosed master controllers, or by automatically responsive accessory devices.

Some instances of recently developed commercial devices which point out this trend, are, phase reversal devices especially useful in elevator controllers, where a reversed phase will send the car in the wrong direction, and often through the limits of travel; phase failure devices to protect a loaded polyphase motor from running on single phase as may happen when one line fuse fails; no voltage protection and effective overload protection on starting switches for small alternating current motors that must be thrown directly on the line to get enough torque for starting; the requirement of both manual and remote automatic operation of the control for motors on the important elements of submarine boats; and the same duplicate method of operation of motors driving pumps for fire protective service.

The field of application for the control designer's ingenuity is broadening daily. The opportunity for development was never before so great as now, and it will continue to grow greater. While a specialized branch of engineering, it requires a breadth of engineering mind that can understand the conditions in all industries employing electric motor power. The product of the control engineer is true engineering in the broadest sense, in that it helps to do the work of the world better or cheaper than it was done before.

THE DIVISION OF LOAD AMONG ALTERNATING CURRENT MACHINES IN PARALLEL

F. D. NEWBURY, '01*

This subject involves fundamental principles of considerable importance in practical alternating current work, and, for this reason, seems particularly appropriate for presentation in The Sibley Journal.

The main purpose of the article is to present the subject with reference to synchronous frequency changer sets, but, in order to develop the subject in the simplest way, the more familiar cases of engine driven D. C. generators and alternators are considered first. This subject has assumed, in recent years, an increased importance on account of the growing standardization of 60 cycles in transmission systems and the consequent use of frequency changer sets for such applications as require lower frequency. An example of this is the supply of power for 25-cycle single-phase railways from existing sixty-cycle power systems.

When two or more turbine-driven alternators are connected in parallel, two new operating requirements are introduced: first, the generators must all operate at the same frequency; and second, they must operate at the same voltage, the same both in magnitude and in phase. The results that follow the requirement of equal voltage will be investigated first.

If, with two D. C. generators operating in parallel, the field current of one is increased, its terminal voltage tends to become greater than that of the other. This is an unstable condition, because any difference in voltage causes a current to flow in the local circuit formed by the two armatures that will increase until the terminal voltages are again equal. The direction of this equalizing current is, of course, in the direction of the higher voltage, so that it adds to the current supplied by the overexcited generator to the external load circuit and subtracts from the load current supplied by the underexcited generator. The question may arise in the reader's mind: why does this current continue to flow after this equalization of terminal voltages is accomplished? The primary cause of this current flow is the difference in excitation, and the current flows as long as the difference in excitation persists. This difference

*Engineer in charge of Power Engineering Department, Westinghouse Electric & Manufacturing Co.

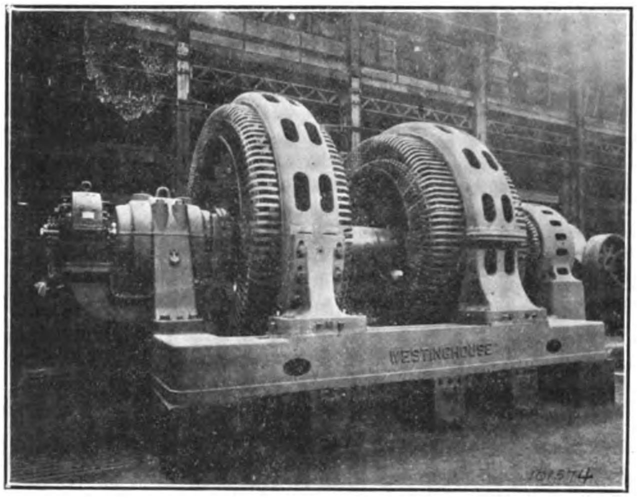


Fig. 1. Frequency Changer

in excitation produces a difference in internal induced voltage. The resulting equalizing current produces equality in terminal voltage through two separate actions: first, the increased armature reaction in the overexcited generator decreases the flux which in turn decreases the induced voltage; and second, the increased current results in a greater internal voltage drop. Similarly, the reduced armature reaction in the underexcited generator increases the induced voltage and the reduced internal drop again increases the terminal voltage. Equalization is secured by a reduction in one voltage and a simultaneous increase in the other. With brushes on the neutral at all times, as is the case with commutating pole generators, the flux due to the current in the armature winding is always at right angles to the flux due to the current in the field coils. The D. C. generator with brushes on neutral may be compared, from the standpoint of armature reaction, with an alternator in which by some means the armature current is compelled to stay in phase with the terminal voltage.

The same reasoning may be applied to alternators operating in parallel. As in D. C. generators, an increase in field excitation of one alternator tends to increase its induced voltage and terminal voltage; this in turn causes an equalizing current to flow between the two alternators and this current reduces the flux and increases the voltage drop in the overexcited alternator, and has the reverse effect in the underexcited alternator, with the result that the terminal voltages are again made equal. Two important differences between the action in the D. C. and A. C. generators should be noted, due to the possibility of difference in phase in the latter. The first difference is that, since the "loop" circuit consisting of the two alternator armatures, has negligible resistance as compared with reactance—the ratio is seldom less than 1 to 20 in large alternators—the equalizing current does not represent an inter change of power as it does in the case of D. C. generators. The phase relations are such that the equalizing current lags nearly 90° behind the induced voltage of the overexcited alternator and leads the induced voltage of the underexcited alternator by slightly more than 90°. The flux of this equalizing current, therefore, almost directly opposes the resultant flux in the overexcited alternator and almost directly assists the resultant flux in the underexcited alternator. This equalzing current is, therefore, very effective in neutralizing differences in field excitation, as compared with the corresponding action in D. C. generators. Whereas in DC generators. relatively small differences in excitation can result in actually reversing the armature current in the underexcited generator, the excitation of one alternator may be very great compared with that of the other, without seriously modifying the relative total currents.

The second difference between the action that takes place in two D. C. and in two A. C. generators in parallel is due to the fixed phase relation of the two A. C. terminal voltages. The addition of the lagging equalizing current to the original current of the overexcited generator, and of the leading equalizing current to the original current of the underexcited generator, produces a two-fold change in relative phase of the two generator currents. The phase of the armature flux, or armature reaction, changes with the phase of the armature current. The flux in the air gap, that generates the induced voltage, is the resultant of the flux due to the main field winding and of the armature flux. The change in phase of the armature flux produces a considerable change in the phase position of the resultant flux and induced voltage. Since, however, the phase position of the terminal voltage is fixed by parallel operation, the change actually occurs in the phase of the main field flux and in the relative positions of the rotors of the two generators. In the overexcited generator, the lead of the rotor flux, due to load, is reduced, and in the underexcited generator this lead is increased. This change in rotor position, with change in excitation. may be visualized by picturing two duplicate generators driven by single-crank engines. Assume that the generators are synchronized so that the two cranks have the same position at the same instant, i. e., if the two generators are side by side, the two cranks are in line and rotate together. If 100%

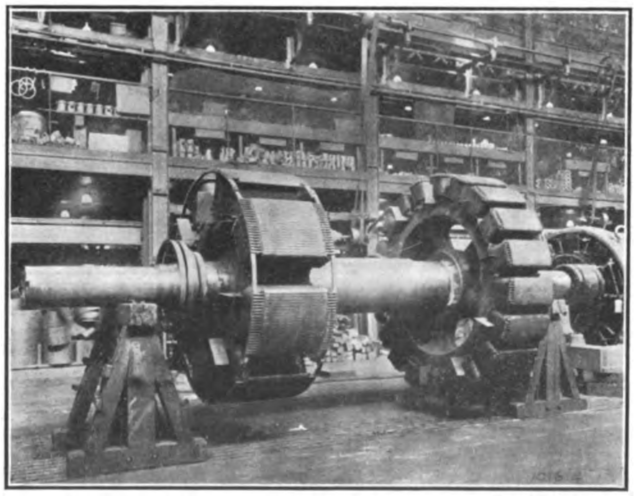


Fig. 2. Rotor of Frequency Changer

power load is added to both generators, the two cranks will draw ahead of the position they would have had at the same instant of time without load. If the field excitation of one generator is then increased, the crank driving that generator will drop back from the position it would have had and the crank driving the other generator will draw ahead; that is, the two cranks will no longer be in line. This relative change in phase of main flux and in rotor position is usually of no importance in the parallel operation of generators, because the rotor is not rigidly held to one position. In the special case of generators driven by synchronous motors, the generator rotors are held to definite positions and this matter of change with excitation becomes of prime importance. This will be discussed later in connection with the parallel operation of frequency changer sets.

In the case of D. C. generators, the equalizing current resulting from changes in excitation is, of course, an energy current and directly adds to or subtracts from the load currents supplied by the generators. It is customary to consider, then, that the change in excitation directly shifts the load from the underexcited to the overexcited generator. The conception of an intermediate step in the action is hardly necessary. In the case of alternators, however, since the equalizing current does not represent power and has no such direct relation to the load current, the idea of a separately existing equalizing current is convenient, and, in the case of alternators supplying a 100% P. F. load, it becomes almost a necessity. When the alternators supply a load of lower power factor, the result of changes in excitation may be looked upon as a shifting of wattless current from one generator to another.

It is sometimes desired to connect alternators in parallel through a transmission line of appreciable resistance and reactance. This in no way alters the qualitative aspect of the problem. The phase and magnitude of the voltage at the point from which load is taken must be the same, instead of the voltage at the generator terminals being the same, as is the case when the generators are connected by busses of negligible impedance. Or, the impedance of that part of the line from the generator to the point at which load is taken may be treated as part of the generator impedance. A special case of this general problem is the effect of reactance inserted between sections of the bus in a single station to localize the effects of accidental short circuits.

It has been shown, in the previous discussion, that the requirement of equal voltage determines the division of both current and power between D. C. generators in parallel, but controls only the division of wattless current in the case of alternators. It remains to explain the division of power between alternators in parallel. A requirement imposed by parallel operation that is peculiar to alternators is equality of frequency in all alternators in parallel, and it is this requirement that determines power load division.

To present this problem in a simple form, assume that two turbine-driven generating units have the same rating, but that one turbine has a speed regulation of 4%, while the other has a speed regulation of 2%; that is, one unit decreases its speed 4% from no load to rated load, while the other unit reduces its speed only half as much. Since the two generators must operate at the same frequency, when in parallel, each generator will take such a proportion of the total available load that the drop in speed in the two turbines is the same. In the assumed case, the turbine having 4% speed regulation will take only one-half the load that the other turbine will take; in other words, the load will divide in the ratio of one-third and two-thirds of the total load.

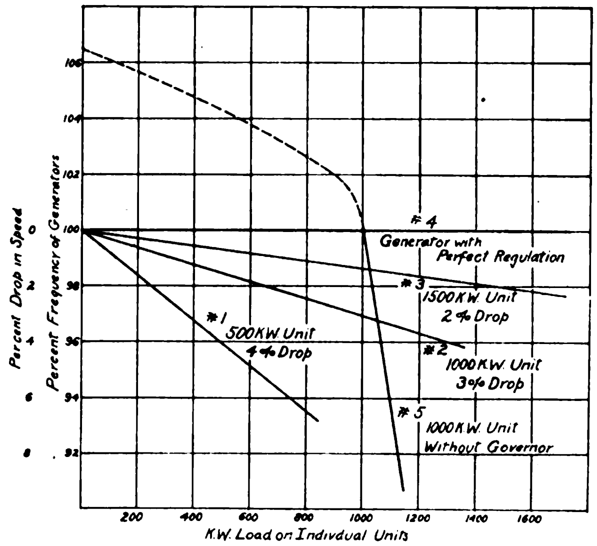


Fig. 3. Speed Load Curves of A. C. Generators

A general statement, that covers differences in rated capacity, as well as differences in speed regulation at the rated capacity, is that the total load will divide among the several turbines in the same ratio as the ratio between loads that will produce equal frequencies in the several generators. For example, if a 500 K. W. unit having 4% speed regulation, a 1000 K. W. unit having 3% speed regulation, and a 1500 K. W. unit having 2% speed regulation, are operated in parallel, they will divide the total load in the ratio of 250 K. W., 667 K. W and 1500 K. W., since each of these loads will cause a 2% drop in speed in their respective turbines. These conditions are illustrated in the curve shown in Fig. 1. The horizontal scale represents the load on individual units so that a horizontal line drawn at any desired speed-drop, such as 2%, represents the loads in K. W., taken by the various units, in order to produce this necessary uniform speed-drop in all of the units. While in this illustration the three turbines are shown as having the same frequency at no load, this is not necessarily the case.

It follows that load can be transferred from one unit to another only by adjustment of speed. If a turbine were equipped with a governor that would maintain absolutely constant speed at all loads, the turbine would not operate satisfactorily in parallel with other units having a speed-drop, since it would take the entire load placed on the busses. The reason for this is obvious: at any load its inherent speed would be higher than

that of any other unit. This condition is also illustrated by Fig. 1, the horizontal line at O speed-drop representing the speed-load curve of the constant-speed turbine, No. 4. A unit having a rising speed characteristic would be even more unstable, so far as load division with other units is concerned. It would necessarily rob all other units, as the more load it assumed, the more it would tend to assume. A necessary requirement for stable load division is a falling speed characteristic of all the units operating in parallel.

If a water wheel, driving a generator, is operated without a governor, and the generator is operated in parallel with other generators having regulated prime movers, the unregulated generator will take a nearly constant load, determined by speed power characteristic of the water-wheel with fixed gate opening, even though the total load on the system varies widely. This condition is illustrated by No. 5 curve of Fig. 1. The speed characteristic of a water-wheel, with fixed gate opening, is very steep—that is, small changes in load produce large changes in speed. If, as shown in Fig. 1, the relative speed characteristics of the turbines Nos 1, 2, 3 and 5 (driving generators in parallel) are such that turbine No. 5 will carry a load of 1000 K. W. at a speed corresponding to zero load speeds of the other units, and the load is then greatly increased, the common speed of the four turbines will slightly fall. The increase in load will divide among the several units, as as already described, in inverse proportion to the slope of the speed characteristics. Thus, if the total load is increased above 1000 K. W. to such a value that the whole system drops in speed 2%, the four units will assume loads shown by the intersection of the horizontal line at 2% speed-drop (Fig. 1) with the several turbine speed curves. Thus generator No. 1 will carry 250 K. W.; No. 2, 667 K. W.; No. 3, 1500 K. W.; and the ungoverned turbine and generator No. 5 will carry 1033 K W. The sum of all these loads is 3450 K. W. Thus, in increasing the total load from 1000 K. W. to 3450 K. W., the load on the ungoverned turbine remains practically constant.

The parallel operation of frequency changer sets may now be considered. Such sets may include an induction motor or a synchronous motor for driving the synchronous generator and the type of motor determines the way in which division of load is accomplished.

With induction motor-driven generators, the load division is determined by the same factors as in engine-driven generators. The slip of the induction motor, provides a flexible connection between the supply and load circuits that permits the generator voltages to assume the same phase without restraint. Changes in excitation result in wattless equalizing currents, as in engine-driven alternators, and the division of energy load is likewise controlled by the speed characteristics of the several induction motors. Obviously, the motors connected to a common supply circuit and driving generators connected in parallel, must operate with the same slip. If the several motors inherently have the same slip at the same load the sets will divide the load equally It is interesting to note that if two frequency changer substations, considerably separated as to distance, supply a single load located near one substation, the two substations will still equally divide the load (neglecting losses) if the induction motors are designed to have equal slips. Under such circumstances, the effect of applied voltage on slip must be taken into account. If the motors do not have equal slips at equal loads, the sets will divide the load in the inverse ratio of the slips.

With synchronous motors, a new condition is introduced. The generators can no longer change their rotor positions freely as load or excitation is changed; the synchronous motor rotor or the flux of the rotor poles has a definite phase position with respect to the applied motor voltage, and this determines the rotor position and the phase of the rotor flux of its generator. Moreover, there is a rigid relation between frequency of

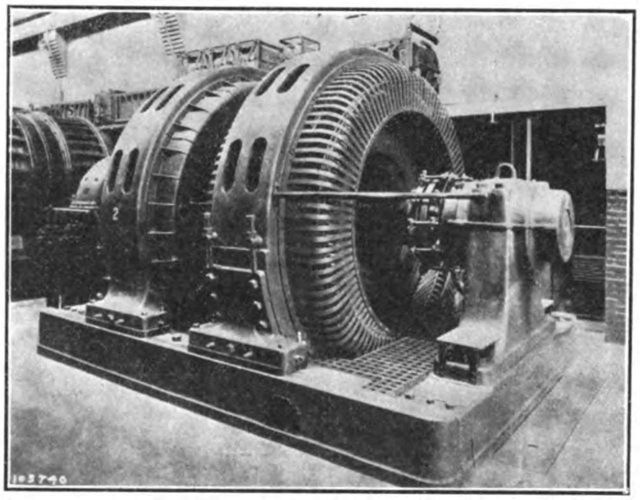


Fig. 4. Frequency Changer

the supply and load circuits. The frequency of the load circuit cannot drop as load is increased, unless the frequency of the supply circuit also drops. Ordinarily, the load added to the supply circuit by frequency-changer sets is small, compared with the total load; consequently, the frequency of the supply circuit may be assumed to be constant, so far as the frequency changer load is concerned.

The problem may be reduced to its simplest form by assuming two sets of the same rating and design to be operated from the same supply busses on the motor side and to be connected to independent busses on the generator side, which may, if desired, be connected to place the generators in parallel. It is assumed, further that the two sets are synchronized on the motor side, and are so adjusted mechanically that the generators, while operating separately and with no load, are also in synchronism.* When load is applied to one generator, the following actions take place:

(a) the motor current is increased;

(b) the motor rotor drops back in phase position,

*Refer to the author's article on "Parallel Operation of Frequency Changer Sets," *Electric Journal*, November, 1916.

due to the internal voltage drop in the armature and to the shifting of the resultant or air gap flux (caused in turn by the increase in the armature flux).

(c) the generator rotor drops back an angle equal, in electrical degrees, to the motor angle multiplied by the ratio of generator poles to motor poles.

(d) the generator terminal voltage drops back in phase position, due to the internal voltage drop in the generator armature, and due to the shifting of the resultant or air-gap flux (caused, in turn, by the increase in armature flux).

Changes (c) and (d) are cumulative and may be directly measured, in the assumed case, by comparing the phase of the voltage of the unloaded generator with that of the loaded generator. In a set of usual design, this change in phase of generator terminal voltage from no load to rated load will be in the neighborhood of 100 electrical degrees, on the basis of 25-cycle to 60-cycle transformation and 100% power factor on both machines. This figure is made up of a motor shift of 30,° which transferred to the 60-cycle generator, is 72 electrical degrees, and of an additional shift of 30° in the generator.

If these two generators are now connected in parallel, this difference in voltage phase must disappear, and the readjustment is accomplished by a current flowing between the two generators. The voltage causing this current is the resultant of the two generator voltages, and from the standpoint of the local circuit formed by the two generator armatures and the bus bars, these voltages are normally in opposite phase relation. Their resultant, therefore, is roughly 90° out of phase with both, and the current, being 90° out of phase with the resultant voltage, is approximately in phase with the voltage of one generator and in opposite phase relation with that of the other. This current, therefore, has a large energy component and represents a transfer of energy load from one generator to the other. A readjustment of terminal voltage phase, therefore, involves mainly a shifting of energy load; a readjustment of terminal voltage, in magnitude only, involves a shifting of wattless load.

In order to investigate the effect of a change in generator excitation, assume that, with the two frequency changer sets operating in parallel, and with the two generators at the same power factor, the excitation of one generator is increased. This, as previously explained, causes a wattless equalizing current to flow between the two generator armatures that equalizes the terminal voltages. It also changes the power factor of the two generators and this tends to change the realtive phase position of the rotor fluxes. This relative position, however, is rigidly held by the mechanical connection of the two generator rotors to the motor rotors. This resistance against change in rotor position results in a shifting of energy load between the two sets. In the parallel operation of frequency changer sets a change in excitation results in a shifting of energy load as well as in wattless load. A change in motor excitation will, for the same reasons, result in shifting both energy and wattless current on the motor side and a shifting of energy load on the generator side.

The location of frequency changer sets in widely separated substations with appreciable impedance in the connecting lines does not alter the conditions governing load division. The line impedance from the source of power supply to each motor may be added to the motor internal impedance and treated in the same way and the line impedance from each frequency changer set to the point in the distributing lines from which load is taken may be treated in the same way as the generator internal impedance. The governing condition, as in the cases previously considered, is that the voltage phase of the several generators shall be the same at the point in the distributing lines at which the several generator circuits come together to form one load circuit. The several sets will divide the **wattless** load so that the **magnitude** of the voltage delivered by each generator to the point in the line from which load is taken will be the same; and the sets will divide the **energy** load so that the **phase** of the voltage delivered by each generator to the point in the line from which load is taken will be the same.

Differences in line impedance from the several generators to the point of load application on the high frequency side are relatively unimportant, as compared with such differences on the low frequency side. This is obvious when it is remembered that a given change of phase on the low-frequency side is multiplied by the ratio of high to low frequency (2.4. with 60-cycle 25-cycle transformation) when compared, in electrical degrees, with such changes on the high frequency side. Also, the phase shifts caused by usual differences in line impedance to each motor or from each generator of the several sets are small, as compared to the total shifts due to the motor and generator of the set. Accordingly, load division is not greatly affected even by wide separation of the frequency changer sets. If several large sets are installed in substations a hundred miles apart and the total load on the sets is concentrated near one of them, all of the sets will take nearly equal shares of the load. This assumes that the motors and generators have their excitations adjusted for equal power factors in the motors and in the generators, respectively. Any factor that affects the voltage phase shift of the set, and particularly that of the low frequency machine, will appreciably affect the load division. The load division in widely separated sets may be compared with the current division among several branch circuits of high impedence connected together by lines of relatively low impedance. Changes in the impedance of the connecting lines cannot seriously change the division of current among the branch circuits.

ELECTROLYSIS

JOSEPH F. PUTNAM, '10*

If two platinum plates A and B Fig. 1, are immersed in a vessel of acidulated water and a current of electricity sent through in the direction shown by the arrow, the water is decomposed into its constituent gases, which are given off as bubbles at the plates A and B respectively. If iron is substituted for the platinum it will be found that the plate A becomes lighter and that iron is carried from it through the liquid and deposited on plate B. The amount of metal so transferred can be determined from Faraday's Law. This decomposition or breaking up of material due to the passage of electric current through an electrolyte

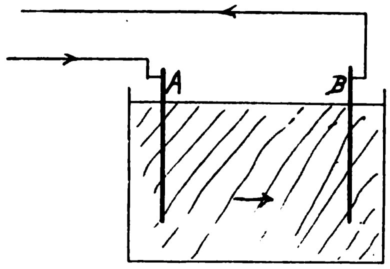


Fig. 1.

is called electrolysis. If, in place of the acidulated water, we substitute moist earth the action is somewhat similar, but the amount of metal carried away from plate A for a given current is very much less than Faraday's Law would indicate while plate B is not appreciably increased in weight.

It was early found that the earth was a conductor of electricity, and the telegraph industry has always used the earth as a return conductor. Telephone companies also have utilized the earth as a return conductor, but in most of our present commercial telephone systems a complete metallic circuit has been substituted. The electric railway companies, following the practice laid down by the telegraph and telephone companies, attempted to use the earth as a return conductor, and found for the first time that there was a limit to the amount of current that the earth would carry economically, and that some kind of a metallic return was necessary. The rails themselves furnished the simplest kind of return circuit. As the density of traffic increased, not only was it necessary to increase the size of rail, but also to pay particular attention to obtaining good electrical bonds between the adjoining ends of these rails. The rails, being for the most part either imbedded in the earth or in electrical contact with it, form, however, only one part of a multiple path for the return of the current back to the power house.

In many cases the rails are parallel with a network of underground metallic structures, such as water pipe, lead cable, gas pipe, etc., and then the amount of current which returns by conductors other than the rail is enormously increased. In Fig. 2 the conditions are shown when the rail is paralleled with a water pipe. The current which passes through the car into the rails divides; the larger part of it usually returns through the rails, while the remainder leaks through the earth, which it then uses as a return conductor back to some point near the power house, at which point it again leaks through the earth into the rail and thence to the generator. At a distance from the power house the pipe is generally negative to the rail and only in the vicinity of the power house is the pipe positive to the rail. Where the current leaks from the rail to the pipe, through the earth the rail is slightly decomposed and rusted away, but such rusting away or decomposition is very slight compared with the actual aging of the rail due to wear and tear. That is, the rail will have to be replaced for reasons other than this electrical decomposition. Where, however, the pipe is positive to the rail, the chances are that the pipe area which is actually positive is comparatively small and the current density fairly large. The result is that the wearing away of the pipe is apt to proceed at a dangerous rate and a burst main with its consequent damage is the result.

When the street railway industry was in its infancy the railway engineers often tried to help out their return by bonding the rails with a metallic connection to the pipe. This increased the amount of current flow in the pipe and of course increased the danger incident to electrolysis. It was not until 1895, how-

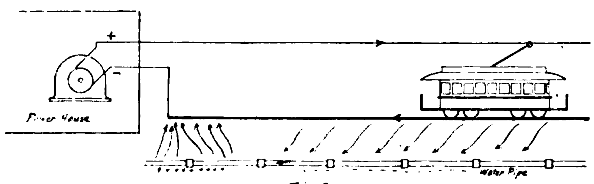


Fig 2.

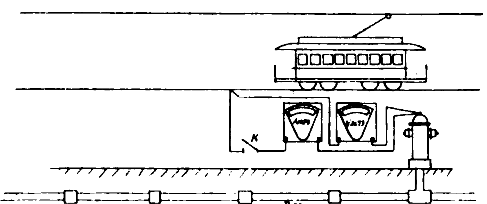


Fig 3

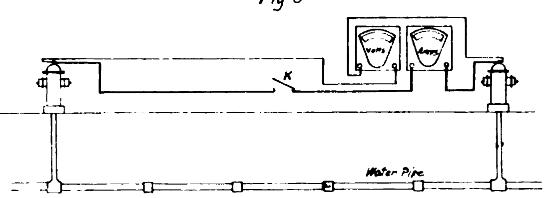


Fig 4

*Asst. Prof. of Elect. Eng. Cornell University.

ALUMNI SEE PAGE 191

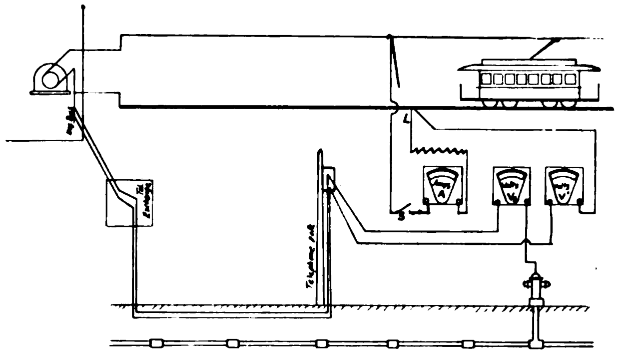


Fig 5

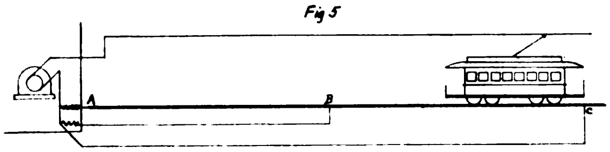


Fig 7

ever, that the real cause of the damage was discovered, and immediately engineers demanded that these metallic connections between pipe and rail be discontinued. As the trouble still continued, bonds at the power house between pipe and rail were made so that the return current in the pipes could be drained out through a metallic connection instead of an electrolytic one. Better bonding of the rail joints was also advocated and numerous types of bonds appeared on the market.

While these remedies were effective for a considerable time in decreasing the amount of damage done by electrolysis, the increased traffic and consequent increase in size of motors soon brought the leakage current again to dangerous proportions and it was found advisable in many cities to make a complete electrical survey of the conditions existing, and many suggestions were made as to the necessary electrical measurements.

Since it was only where the pipe was positive to the rail that danger could exist, the first tests made were voltage measurements to determine the difference of potential and the polarity between pipe and the rail. The rail was accessible but the pipe could be reached only by digging or by using the hydrants scattered around the system. Difference of potential, however, does not prove current leak, any more than pressure in a pipe indicates a leak. Such potential differences, do indicate a tendency to leak, the other element being the resistance between the pipe and rail. Several attempts have been made to determine this resistance both mathematically and by actual test, but not with very satisfactory results. Perhaps the simplest method advocated is that due to Herrick* which is illustrated in Fig. 3. The voltmeter is read first with the switch K open and then with it closed; while closed, the current value is also read. Then

$$\frac{\text{Difference between the two voltmeter readings}}{\text{Ammeter reading}} = \text{Resistance between pipe and rail.}$$

and

$$\frac{\text{First voltmeter reading}}{\text{Resistance}} = \text{Amperes current leak.}$$

The above formula is true if the amount of current returning to the power house through the rails is not changed by closing switch K. It is at any rate a good indication upon which to base further measurements and possible recommendations.

Another test frequently made is that of current flow in the piping system. The pipe is exposed and millivoltmeter measurements made from which, with a knowledge of pipe resistance, the amount of current flowing in the pipe may be fairly accurately determined. Herrick suggests that a fair approximation may be made from the surface of the ground by stretching a conductor of large cross-section between two hydrants as shown in Fig. 4. An extra lead for a voltmeter is also run and measurements made as follows:

1. Voltage with switch K open
2. Voltage and current with switch K closed

then

$$\frac{\text{Difference between the voltmeter readings}}{\text{Ammeter reading}} = \text{Resistance of pipe between hydrants}$$

and

$$\frac{\text{First voltmeter reading}}{\text{Resistance of pipe}} = \text{Amperes current in pipe.}$$

Another test frequently made is to determine the potential gradient along the rail. The telephone companies are usually sufficiently interested in an electrolysis survey, on account of the threatened danger to lead cable, to lend the use of a pair of wires for purposes of pressure measurements. The connec-

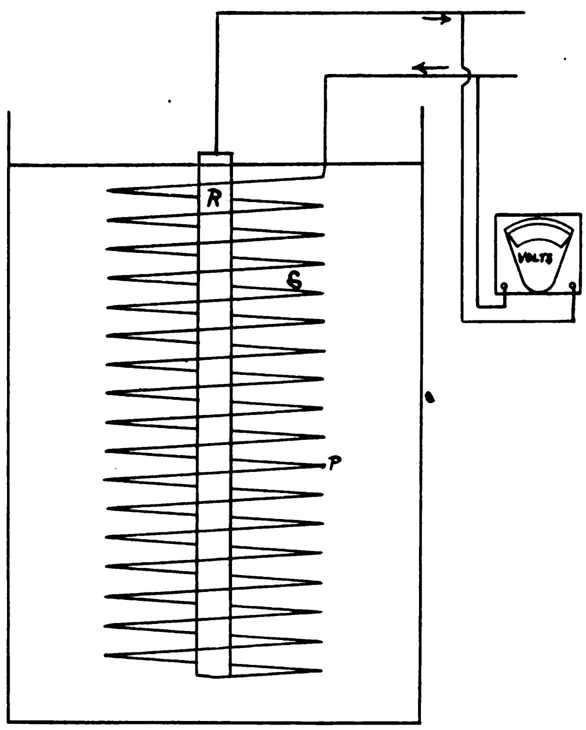


Fig. 6

*St. Ry. Journal 1898.

tions for this test are shown in Fig. 5. At the point of test, the exchange is called up and asked to connect the talking line directly to a pair of wires, the other ends of which are connected to the negative bus. This gives a pair of pressure wires from the negative. bus to the point under test. Corrections of course must be made for the resistance of the telephone wires

In connection with the above test it is possible to measure the resistance of the return path. By closing the switch S the voltage V_1 will rise due to the current A. This rise in voltage divided by the current causing it is equal to the resistance of the rail return. The resistance of the pipe return could have been determined by connecting the wire L to the hydrant instead of to the rail, and using voltmeter V_2.

Inasmuch as the actual resistance of the soil varies in different parts of the system, it is often advisable to measure the actual resistance per cubic foot of earth. A cubical box with a one foot edge and metal ends may be used to advantage in making such a test. Resistance found with direct current will be considerably higher than that found with alternating current. Further, due to polarization, the direct current resistance will increase with the length of time during which current is allowed to flow.

Another interesting test due to Herrick is that of determining the lowest voltage at which corrosion will occur in the ground water, samples of which should be taken from different localities. A piece of soft iron wire is coiled into a spiral S and immersed in a vessel containing the sample of ground water, Fig. 6. The lower end of the wire is fastened to the rod R which is symmetrically placed with respect to the spiral. If then, an electromotive force is impressed across the terminals as shown, for a considerable period of time, electrolytic action will take place between the upper spirals and the rod, and some point P will be found where this action ceases, that is, in order to cause electrolytic action a voltage higher than that existing between point P and the rod must occur. This voltage can be easily computed by measuring the total length of wire and the length from the bottom end to point P. The ratio of these two lengths multiplied by the voltage impressed gives the voltage between points P and R.

In one of the first court cases involving electrolysis the railway company was ordered to stop using the earth as a return and install a double trolley system. There is no doubt but that this is the best means of preventing electrolytic action. The Japanese government is using the double trolley wherever possible with this end in view. The objections to this cure, however, are many. In the first place it is very expensive. A complete overhead copper system and companion feeders must be installed for the negative as well as for the positive line. The mechanical difficulties involved in keeping one trolley on the wire are many, and with two parallel wires the difficulties are multiplied enormously.

The Bureau of Standards is recommending the insulated return system of negative feeders. Fig. 7 shows the application of this method to a line of track. Points A, B and C are each connected by feeders to the negative bus. Resistances are included in the various feeders so that the potential at points A, B and C, are equal. The main objection to this method of limiting damage due to electrolysis, is that it is usually necessary to spend $100 for every dollar of damage prevented, which is bad business and poor engineering.

The earliest remedy suggested, as mentioned above, was to install bleeder or drainage wires between pipe and rail, in the territory where the pipe was positive to the rail. While this method undoubtedly increases current flow in the pipe, it is still by far the most popular remedy. This is partly due, of course, to the low cost of installation but also to the very satisfactory results that have been obtained in many cities by this method. It is only a partial remedy and changing conditions necessitate a frequent survey of the territory.

Another early remedy consisted of inserting insulating joints at several places in the piping system. This method has shown good results and is worthy of further consideration.

Since electrical decomposition is practically absent when alternating current is used, it has been suggested that the polarity of the system be occasionally changed at the power house, so that the amount of metal dissolved from the pipe while the current flows in one direction might be redeposited by a reversal of current. The Bureau of Standards has made some very careful tests recently which indicate that a reversal every twelve hours will probably effectually stop electrolytic corrosion. One of the objections raised to this method is that the law in most states specifies grounding the negative side of the generator.

Most cases of electrolytic trouble could have been stopped by the installation of a better return circuit. The railway companies are beginning to realize this, and welded joints and bonds are the result.

As traffic becomes heavier and car motors become larger the ground currents are bound to increase. This means that trouble from electrolysis may be expected to increase. It is therefore necessary, in order to be prepared, that a knowledge of existing conditions be available and that frequent surveys be made and prevention methods kept abreast of the increased danger.

PERSONALS

Mr. Geo. A. Wardlaw, '93, editor of The Electrical Record since 1910, resigned that position March first in order to engage in free lance literary work.

Mr. H. G. Weidenthal, '13, is with the Standard Chemical Company of Cannonsburg, Pa. His address is 506 W. College Ave.

Mr. McRea Parker, '14, is with the Bell Telephone Company, 1230 Arch St., Philadelphia, Pa.

(Continued on page 12, ad.)

SIBLEY DIRECTORY

Directory of 6500 former students of Sibley College

SECOND DIRECTORY NUMBER TO BE PUBLISHED SOON

SUBSCRIBE NOW

NO EXTRA COPIES PRINTED

YOUR SIBLEY DIRECTORY

The Second Directory Number of the Sibley Journal of Engineering which is to appear very soon is to contain information concerning all former students of Sibley College. We, as well as you want this information as complete and correct as possible. Your classmates and friends want to find information there concerning you. In order that this may be complete and correct, we will need *your* co-operation.

Have you sent us the information we desire?

If not fill out and return the attached blank NOW.

INFORMATION FOR THE SIBLEY LIST

PLEASE WRITE LEGIBLY

Last Name Given Names Degree and Year

Title and Occupation

Home Address

Business Address

Address for Mail

Societies you are a Member of

We will appreciate the courtesy if you will fill out and send us this blank immediately. Address THE SIBLEY JOURNAL, ITHACA, N. Y.

Please reserve one copy of THE SIBLEY DIRECTORY Number of the Journal, for which I agree to pay 50 cents upon delivery.

Signed..

ENGINEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Gray, Prof. McDermott, Prof. Diederichs, Prof. Albert, Prof. Wells, Prof. Ellenwood, Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Gage, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Lee, Asst. Prof. Pertsch, H. W. Brown, F. G. Tappan, F. L. Fairbanks, J. F. Wait.

The Sibley Journal will mail the magazines containing the articles abstracted to its subscribers at cost price.

Panama Canal Shops at Balboa, by Frank A. Stanley, *American Machinist*, February 22, 1917.

The great shops of the Panama Canal, located at the Pacific Terminal, Balboa, are of unusual interest, owing not only to their magnitude and their thoroughly up-to-date features of construction, but also because of the diversified character of the work handled there in.

These shops were authorized by Act of Congress, August 24, 1912. As completed they consist of 26 buildings, 12 of which may be considered as main buildings; the others are smaller and less important structures used for various purposes. The shop buildings of this plant, as completed and equipped with machinery, form important object lessons in building design, and construction, in arrangement of machinery and in methods of conducting the operations in the plant.

These shops are unique in their purpose. While they constitute a Government plant, they are intended also, to do machine work for private establishments, for private lines of steamships and for the Panama Railroad. They not only take care of construction and repair work for the Panama dredging and towing fleet, for naval vessels, passenger and cargo steamers of all kinds, but work for private firms is also done.

The drydock just completed will admit the largest vessels afloat. The car shop and the section of the machine shop devoted to railroad work take care of the entire equipment of the Panama Railroad. In regard to the variety of work done in respect to both size and character, possibly the closest and only approach in this country is represented by the Great Southern Pacific Repair Shops at Sacramento, Cal. The area on which these buildings are erected is about 36 acres in extent and was originally of low-lying swampy character. In preparing the foundations a great many piles were driven, and many caissons required. Over 5000 piles were used in the preparatory work before the erection of the buildings. Under the machine shops, in particular it was necessary to resort for foundations at certain points to the use of steel caissons four feet in diameter, supported by steel rails and concrete extending down to solid rock.

C. W. H.

Installation of Thermometers, by W. A. Tailer. *The National Engineer*, February, 1917.

One of the most important factors and considerations in power plant practice is temperature, and hence the selection, installation and care of the instrument for measuring this condition, the thermometer, should receive more than passing attention.

The first requisite of the thermometer is that it be accurate and correct, and aside from the original design and construction which is usually taken care of in a satisfactory manner by the reputable manufacturers, the two points on which special emphasis should be placed are:

1. To see that the instrument is adapted for the particular class of work to be done.

2. To see that the instrument is properly installed and connected up.

For power plant work thermometers may be divided into the following classifications, according to the range of temperatures encountered.

Class of work	Temperature which should be covered
Feed water	30° to 240° fahr.
Condenser water	30° to 160° "
Economizer	50° to 400° "
Superheater	200° to 800° "
Steam lines (for checking pressures)	200° to 340° "
Flue gas	210° to 1,000° "
Air temperatures	0° to 160° "
Ordinary testing work	–30° to 120° "
	30° to 220° "

For furnace work and other extremely high temperatures a special form of thermometer, the pyrometer, should be used.

In making selection of a thermometer consideration should also be given to the desirability of using a recording thermometer in place of the ordinary index or indicating scale thermometer. The recording thermometer has the tremendous advantage over the plain index thermometer of giving a continuous and graphic record of the temperature maintained, covering the entire day and night.

Another advantage of the recording thermometer is that more convenient installation can be made, i.e., the expansion bulb can be located where necessary, while the recording apparatus can be installed at some convenient point where it is accessible and where there is plenty of light for reading and adjustment—as for instance, on the central gauge board with all the other gauges and instruments.

For all practical purposes the recording thermometer is as accurate as the ordinary glass tube thermometer, and as a general rule it is also not as fragile and therefore not as easily broken. The fact, however, that the recording thermometer costs considerably

(*Continued on page 8 adv.*)

(*Continued from page 161*)

of training which was important fifty years ago and which is just as essential to success to-day. It is the development of an ability to apply judgment or common sense in the analytical solution of problems, without which the engineer is academic and, therefore, inefficient.

Essentially, advanced education is intended to prepare men for the solution of the problems of everyday life in all fields. Most of these involve judgment largely. Necessarily a large part of the problems which form an undergraduate course are assigned for the purpose of teaching principles and methods of solution which others have found effective. In the time available for technical training this plan undoubtedly permits the covering of the large field of knowledge which must form the background for engineering practice. But necessary as these problems are assumed to be they are not enough for one who aims to be more than a mere follower in the engineering ranks. The limitation to their educational value is due to the fact that in many cases there is but one correct answer which can be reached by patient following of routes already marked out.

The highest type of problem begins in perplexity, it may have several correct answers, and judgment plays an important part in its solution. One does not need to wait for graduation to find such problems, they are always "lying around loose." It is the ability to obtain results off the beaten track that is so much appreciated by employers of technical and other graduates. Employers are usually desirous of knowing much regarding the occupations outside the classroom of applicants for positions. The reason is that the man who can carry through some project, in fact any project, on his own initiative is worth infinitely more in business than is the man who has merely, one might almost say blindly, followed a set routine of lectures, recitations and the other mechanical elements of an education.

Sibley College alumni have set a high standard for initative, resourcefulness, originality and common sense. They did not get these qualities by any slavish following of routine. To their native gifts in these lines, developed by careful home training, they, in the helpful atmosphere of the college, applied themselves to some problems which necessitated a real struggle from perplexity to achievement.

H. H. Norris, '96.*

*Associate Editor Street Railway Journal, formally head of Elect. Eng. Dept., Cornell Univergity.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI MAY, 1917 No. 8

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year

Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR MAY, 1917

Are Honor Men Successful?

Do the honor men of the colleges justify by performances the promise of their student days? The popular impression is that they do not. The remark that valedictorians are never afterward heard of is a common one. Yet the attempt to collect data on the subject always results in conclusions at variance with the popular impression. Investigations say that the honor man's chance of success is distinctly better than that of the mediocre or the poor student.

Interesting evidence on the question is afforded by the Civil War records of West Point graduates. The data here is more definite than when collected in regard to civil colleges. The men are numbered according to class standing at the Academy, and since all were engaged in the same kind of work, one standard can be applied to all.

Six men acquired during the war great reputations which history has confirmed. These were Lee, Jackson, Grant, Sherman, Thomas and Sheridan. Four of them stood in the upper third of their respective classes, two stood in the middle third.

Six army commanders defeated superior numbers in battles or campaigns. All six stood in the upper third of their classes and three were from the upper tenth.

Six army commanders allowed numerically inferior forces to defeat them. Five of these were from the lower two-thirds of their classes; one from the upper tenth.

Six army commanders possess the distinction of never having won a battle or campaign. All were from the lower two-thirds of their classes.

In the Union Army, generals who failed to win were removed. The list of army and corps commanders for 1864, therefore, represents the survival of the successful. In the list of thirty-five West Point men, twenty-three came from the upper half of their classes, twelve from the lower half. Nine came from the upper tenth and none from the lower tenth.

The evidence of the Civil War, then, confirms the findings in other cases. Honor men show a better record of achievement than those whose college record is not so good.

No man need fear that strict attention to his legitimate college work will jeopardize his future career.

S. S. GARRETT.*

*Asst. Prof. of Mechanics, Cornell University.

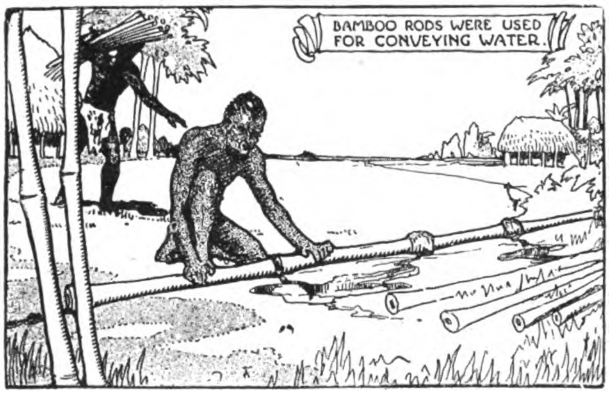
MANUFACTURE OF WELDED STEEL PIPE

CORNELIUS F. ROLAND, '09

History of Pipe

It is known that in early history bamboo, which grows in various diameters in tropical countries, was used for the conveyance of fluids. Even to-day it is used by "coolie" gardeners for conveying water along the surface of the ground for short distances. After the use of bamboo, we find that pottery tubes were used, and remains of these have been found in Egyptian, Aztec and other prehistoric remains which have been brought to light by the excavations of archaeologists.

In the Grecian and Roman civilizations, lead tubes were largely used, and in many museums to-day lead pipe is shown recovered from the ruins of Pompeii, Herculaneum and other buried cities. Pliny, whose



writings cover about the last three-quarters of the first century A. D., states that "In order to raise water up to an eminence, leaden pipes must be employed."

No doubt the first imperative need for iron tubes was for the manufacture of gun barrels. After the invention of gunpowder, the first cannons were made of bronze, but bronze was too expensive a material for gun barrels and cannon, and the need for cheaper material brought out the earliest application of iron for tubes.

In the early history of iron tubes, the only known method of manufacture consisted of bending an iron plate or strip to form a skelp and the edges were welded together piecemeal by a smith hammering a red hot metal over a rod or mandrel. This was rather an expensive and tedious process. In 1812, an Englishman named Osborn, patented machinery for welding and making barrels of firearms and other cylindrical articles. About the time of Osborn's invention for tube welding machinery, another Englishman was perfecting his process for making coal gas for lighting purposes. Iron tubes for conveying gas were essential; and the inventor of gas light—Murdoch—first collected and used old gun barrels, of which there was an abundant supply at the close of the various European wars, screwing the barrels together into a continuous tube to convey the gas. The extension of gas lighting was very rapid, particularly in the Philadelphia district, and the necessity for the production of iron tubes with greater facility and less cost became apparent.

In 1825, Cornelius Whitehouse invented a process of butt welding wrought iron tubes, which forms the basis of the present-day Bell process. The introduction of the Whitehouse invention at once not only greatly reduced the price of iron tubes, but supplied a far superior article.

The successful introduction of artifical gas for lighting purposes, tubes for boilers, an ever-increasing demand for a permanent conveying system for water supply systems and numerous other conditions, necessitated the establishment of domestic industries for manufacturing pipe.

Probably the first furnace for making butt Weld pipe in the United States was built between 1830 and 1834, by the firm of Morris, Tasker & Morris, in the cellar of a shop at Third and Walnut Streets, Philadelphia, the welder being William Griffiths, who had followed that trade in England. In 1836, this same firm erected a mill and machine shop on the block of ground now bounded by Fourth, Fifth, Morris and Tasker Streets, Philadelphia. This was known as the Pascal Iron Works. In 1849, a building was erected, having space for nine welding furnaces together with the necessary machinery.

On July 1st, 1847, James J. Walworth, of the firm of Walworth & Nason, of Malden, Mass., sailed for England, to investigate the tube making industry in that country. He inspected the various works and sailed home September 4th, bringing with him plans for the erection of a tube mill. The following year, the Wanalancet Tube Co., of Malden, Mass., was formed, and special engineers were brought over from England to assist in the erection of a mill. On November 3d, 1849, the first tubes and pipes were made, and in that year they manufactured 1" pipe, ¾" pipe, and 3" flues. Among the other early pipe mills established, in addition to those named were· Griffith Bros., Philadelphia, Pa.; Seyfert, McManus & Co., Reading, Pa.; Allison & Co., Philadelphia, Pa.; Girard Tube Co., Philadelphia, Pa.

There were also small mills at Exeter, N. H., Taunton Mass., Brooklyn, N. Y., Jersey City, Conshohocken, Pa., and two near Boston.

Coming now to the methods of manufacture of modern pipe, the writer will dwell on the processes employed in the manufacture of steel pipe, since this

(*Continued from page 192*)

more than the ordinary, straight-tube thermometer results in its use only in the more important and vital locations.

After securing a thermometer best suited for the conditions, the next step is to see that it is properly installed and cared for. The vital point of every thermometer is the expansion bulb chamber, which comes in contact with the liquid or gas to be measured, and it is highly important that this bulb be brought in full, direct contact with the flow of the liquid or gas, so that a fair reading is obtained. It is always preferable to install the bulb in a horizontal run of pipe, so drilled and tapped that the bulb is fully immersed in the flow.

In order to secure the desired sensitiveness it is necessary to make the expansion bulb of the thermometer of very thin glass or similar composition. Therefore, for power plant work it is customary to protect this fragile bulb from the force of the current by placing it in an auxiliary socket or well screwed into the wall of the pipe. This well or socket arrangement also has the advantage that it protects the thermometer from any pressure which may be in the line, and hence allows the removal of the thermometer itself at any time for inspection, cleaning, etc.

In order to provide proper contact for conducting the temperature from the protecting socket to the thermometer bulb, the well should be filled with mercury so that this mercury entirely surrounds the thermometer bulb. The absence of this conducting agent in the well is often the cause of false readings, because otherwise space is left around the thermometer bulb. If mercury is not available for this well, cylinder oil can be used and satisfaction obtained. When using cylinder oil in this well care should be taken to see that all traces of water are removed, because under high temperatures this presence of water will cause trouble.

False readings are frequently caused by the accumulation of mud, scale and oil on the outside of these thermometer wells, and even the bulbs themselves, even a very thin coating being sufficient to so greatly reduce the free passage of the heat that a serious error is made.

Before placing a thermometer in any location it should be examined to make sure that the mercury column has not become separated during handling. If it has become separated, it can be made to reunite by firmly holding the thermometer at the top, i. e., the end opposite the bulb, and giving it a quick, jerky throwing motion outward.

Another cause of false readings of thermometers in power plant work is the matter of the failure to compensate for the outside temperature surrounding the instrument. Under ordinary conditions the variation in outside temperature is not so appreciable as to cause any marked inaccuracy.

Thermometers, like any other delicate apparatus, cannot be expected to give satisfactory service where they are subjected to constant vibration or jarring. Pipe lines in which they are installed are often subjected to excessive vibration, and in these cases the accuracy of the instrument should be maintained by inserting thick rubber washers between the thermometer and the socket in the pipe line for the purpose of absorbing and minimizing the shocks.

When a thermometer is installed in a position where it is likely to be bumped or jarred by the passage of the operators, etc., a special extra heavy case should be used, or else a simple form of protecting guard should be placed around it.

For taking temperatures in difficult locations, a "maximum self-registering" type of thermometer may be used.

TESTING

As has been emphasized all along, accuracy should be the keynote of any temperature measuring device, and consequently where any large number of thermometers are installed facilities should be provided for testing them at intervals to see that their accuracy is being maintained, this especially since the testing of a thermometer is a very simple job.

In testing, graduating or calibrating thermometers it is usually the practice to establish two definite points, such as for instance the freezing point and the boiling point and then locate the intermediate graduations by dividing up the scale into parts corresponding to the number of degrees difference.

The freezing point of a thermometer is readily obtained by packing around the bulb of the thermometer a quantity of broken ice, the ice being packed in such a manner that while the tube is entirely surrounded by the melting ice, it does not rest in any of the water resulting from the melting. After remaining in the ice pack for 5 or 8 minutes the location of the upper edge of the mercury column will mark the freezing or melting point.

For ascertaining the boiling point the thermometer bulb is placed directly above a vessel containing boiling water in such a manner that it registers the temperature of the steam being liberated to atmosphere at the boiling point. After being located in this position for a few minutes the position of the mercury column will indicate the boiling point.

An easy method of testing the calibration of a thermometer above 212 deg., or the boiling point, is suggested by the fact that the temperature of saturated steam varies with its absolute pressure, the temperature increasing with the pressure. Since very accurate tables have been prepared and published showing these temperatures and the corresponding pressures, a convenient method of testing can be based on this information.

This consists simply of subjecting the thermometer bulb to the saturated steam at a known pressure, and then noting the temperature it registers to see that it corresponds with the known temperature corresponding to that pressure.

C. H. B.

article has so largely displaced wrought iron pipe on the market. To explain this, he refers you to the most recent figures obtainable, issued by the American Iron and Steel Institute, which show that during the year 1915, 90% of the wrought pipe made in this country was steel. The causes for steel pipe replacing wrought iron pipe are many, but mainly the fact that the largest steel pipe producers who have made a special study of the manufacture of a soft weldable pipe-steel, peculiarly adapted to welding, have succeeded in producing a finished pipe fully as durable, stronger, and far more uniform than wrought iron pipe. The fact that modern

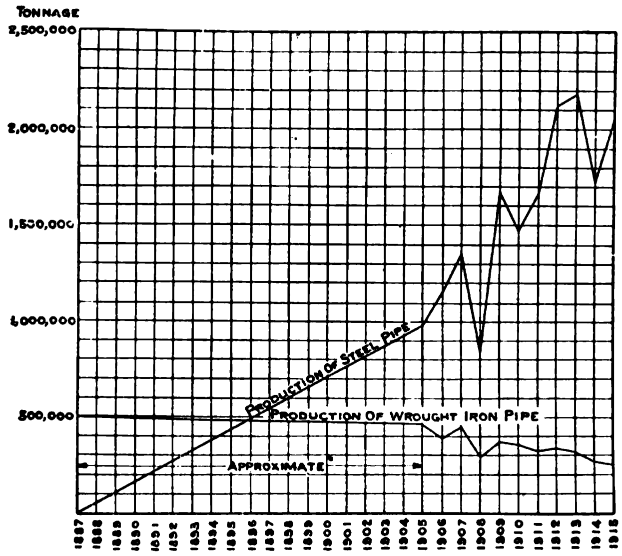


FIG. 1. CHART SHOWING RELATIVE PRODUCTION OF WROUGHT IRON AND STEEL PIPE FROM 1887 TO 1915.

steel pipe is stronger, more ductile and more uniform than wrought iron pipe is not questioned by the engineers of the country, not even the producers of wrought iron pipe, but the question of steel pipe versus wrought iron pipe durability has occupied the attention of the leading engineering societies, technical institutions, and metallurgists for a decade or two, with the result that those who have examined this question from an unbiased viewpoint, have all come to the conclusion that there is no appreciable difference in the corrosion of the two classes of material when installed in the same line, side by side, at the same time and removed the same time, or, in other words, when both are used under identical service.

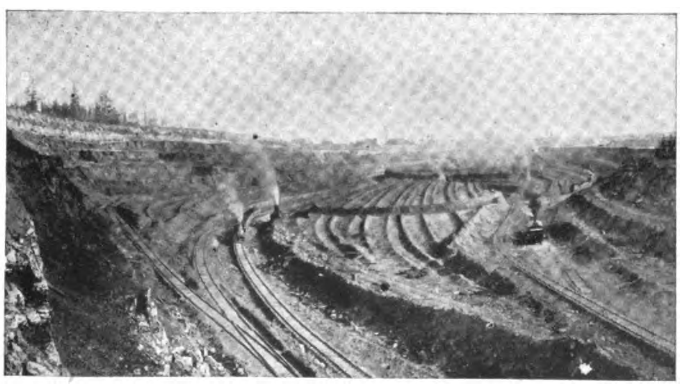


FIG. 2. ORE MINES.

The first step in the operation of the manufacture of steel pipe is the smelting of iron ore in a blast furnace with coke as a fuel and limestone as a flux resulting in pig iron or crude iron. The best ore obtainable in this country is found in northern Minnesota in the Missabe Range. It is a rich reddish-brown Hematite ore containing approximately 60% pure iron. It is found in surface deposits and transported to the coke producing regions, such as the Pittsburgh district.

The ore, coke, lime-stone, are carried by means of a skip-hoist, in the proper proportions to the top of the blast furnace, where they are poured in in alternate layers. Every four hours there is a cast of iron taken from a tap hole at the bottom of the furnace, while every two hours the flux carrying the impurities is tapped from a side hole somewhat higher than the iron tap hole, the flux being lighter than the pig iron. This pig iron which is cast every four hours is run through trenches into huge ladels, which are drawn from the blast furnace department by steam locomotive to the Bessemer Department. To assure an even analysis, and to keep a reserve of pig iron, each ladelful is poured into a huge mixer, which contains about five hundred tons of iron. From time to time, as the Bessemer

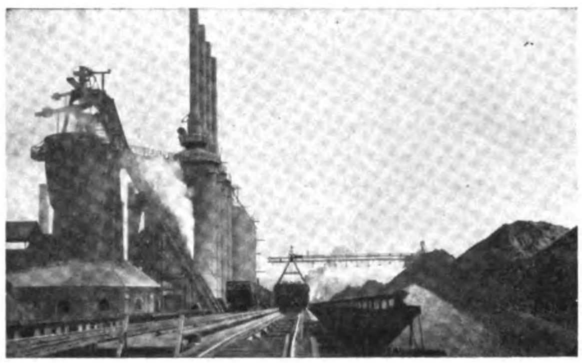


FIG. 3. BLAST FURNACES.

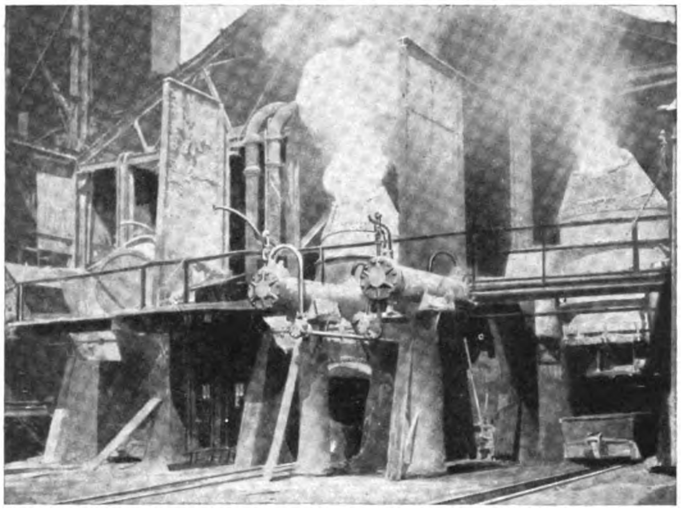
converters require iron, a ladelful of approximately ten tons weight is carried from the mixer and poured into the converter.

The Bessemer converter is a large pear-shaped vessel, consisting of a steel shell, riveted together and supported by two trunnions, upon which it can be made to rotate. One of these is hollow and serves as a wind-pipe to connect the blast from the blowing engine with the wind box at the bottom of the vessel. On the other trunnion is fastened a pinion, which engages with a rack joined to a hydraulic piston, and of such a length that its movement can rotate the converter through an angle of at least 270 degrees. The lining of the bottom is pierced with about two hundred and fifty half-inch holes, which connect the wind box with the inside of the converter and serve for the passage of the blast. The shape of the converter is such that when it is lying on its side, the metal will not cover any of these tuyere holes. This is necessary so that the molten metal will not run into the wind box.

The lining is made of highly refractory acid material, composed principally of silica. It is the usual practice,

in Bessemer plants in America to operate two converters while the third converter of the plant is being re-lined and the bottom carefully dried. Sunday is usually taken up by repairing the converters.

The man who operates these converters is known as the blower, who stands on a high platform and manipu-



lates the movements of the converter with huge throttles. He becomes so experienced in this operation—through practice—that he is able to tell, by the color and shape of the flames, even a hundredth of one percent. the amount of carbon which is remaining in the steel. It is the practice to proudce a soft Bessemer steel, containing about .07 carbon, for the manufacture of pipe. The manganese runs from .30 to .40, while the phosphorus and sulphur are blown down to approximately one-tenth of a per cent. Experience has shown that this grade of soft steel is especially adapted to the manufacture of welded pipe. The Bessemer process assures uniformity and homogeneity of composition, which results in satisfactory welding processes with least loss in manufacture, as well as a better quality of product for all purposes. To accomplish this, it has been found absolutely essential to control the manufacture of metal from the ore to the finished tube or pipe and the practice of the National Tube Company is to make tube and pipe steel exclusively, as by thus concentrating the attention of the highly-trained force of men on this one grade of metal, the best results are obtained.

When the carbon and other impurities are sufficiently oxidized in the converter, the metal is poured into a ladel which is carried by means of a traveling crane to the ingot molds. These molds are filled with the steel and are moved along in succession hydraulically, a continual line of filled molds passing out one end of the mill, while the empty ones are coming in from the opposite end. The filled ingot moulds are taken to the strip house, where the mold is pulled off of the ingot mechanically by means of a plunger pressing the ingot down from the top while the two lifting arms lift the mold up. These ingots are then sheared into blooms or billets and are carried to the rolling mill, where they are rolled to the proper size for certain size skelp. This skelp, or sheet metal, is rolled to a gauge and cut to size for certain size pipe. For the lap weld pipe, the edges of the skelp are beveled in the rolls, while for the butt weld pipe they are not.

All welded tubes and pipe are made either by the lap or butt weld processes. We are able to manufacture butt-weld pipe up to and including 3″, while we are in position to lap-weld pipe down to 1½″. Therefore, in sizes from 1½″ to 3″, we manufacture pipe either by the butt weld or lap weld processes, according to specifications.

The lap weld process consists of two operations, bending and welding. The plate, rolled to the necessary width and gauge for the size of pipe intended, is brought to a red heat in a suitable furnace, and then passed, as mentioned before, through a set of rolls which bevel the edges, so that when over-lapped and welded, the seam will be neat and smooth. It now passes immediately to the bending machine, where it takes roughly a cylindrical shape of a pipe with the two edges over-lapped. In this form it is again heated in another furnace, and when brought to the welding temperature, the bent skelp is pushed out of the furnace into the welding rolls. Each of these rolls has a semi-circular groove, forming a circular pass, corresponding to the size of pipe being made. A cast iron ball or mandrel held in position between the welding rolls by a stout bar, serves to support the inside of the pipe as it is carried through. This ball or mandrel is shaped like a projectile and the pipe slides over it on being drawn through the rolls. Thus every operation of the lapped edge is subjected to a compression between the ball on the inside and the rolls on the outside, which reduces the lap to the same thickness as the rest of the pipe and welds the over-lapping portions solidly together. The pipe then enters similarly shaped rolls, called the sizing rolls, which correct undue irregularities in shape and give the exact outside diameter required. Any variation in gauge makes a proportional variation in the internal

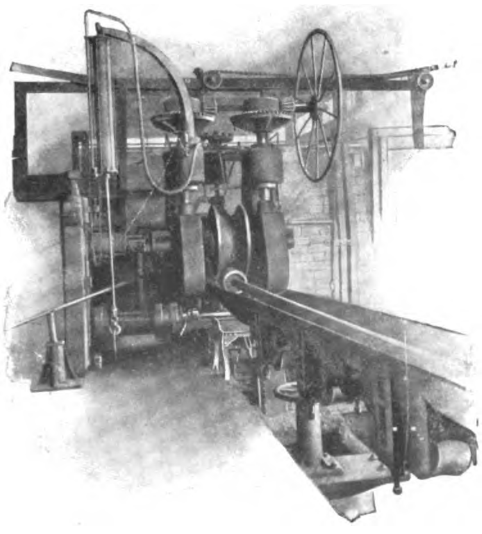


Fig. 5. Lap Weld Rolls

diameter. Finally the tube is passed through the straightening or cross rolls, consisting of two rolls set with their axes askew. The surfaces of these rolls are so grooved that the tube is in contact with each for the whole length of the roll and is passed forward and repeatedly rotated when the rolls are revolved. The tube is made practically straight by the cross rolls, and also given a clean finish with a firmly adhering scale. After this operation, the tube is rolled up an inclined cooling table. When cool enough, the rolls ends are removed by cold saws or in a cutting off machine, after which the tube is ready for inspection and test. In case of threaded pipe, the ends are threaded before testing. In case of double extra strong pipe, 3″ to 8″ sizes, made by the lap weld process, two pieces are first made to such sizes as will telescope one within the other, the respective welds being placed opposite each other. These are then returned to the furnace, brought to the proper welding heat, and given a pass through the welding rolls.

In the butt weld process, the strips of steel or skelp, when properly heated, are seized by their ends with tong and drawn from the furnaces through bell-shaped dies or bells as they are called. The inside of these bells is so grooved that the bell is gradually formed in the shape of a tube, the edges being forced squarely together and

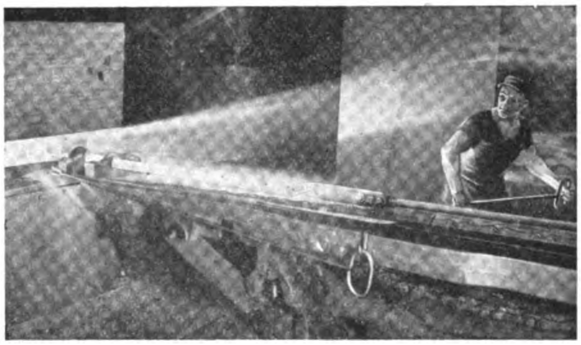


Fig. 6. Drawing of Butt Weld Pipes

welded. For some sizes the pipe is drawn through two bells consecutively at one heat, one bell being just behind the other, the second one being of a slightly smaller diameter than the first. The pipe is then run through sizing and cross rolls, similar to those used in the lap weld process, to secure the correct outside diameter and finish.

An hydraulic testing machine is provided for each pair of threading machines, so arranged that the pipe can be adjusted between two watertight heads connecting the hydraulic line. The test pressure is applied to each length and varies from 600 to 3000 lbs. according to size and thickness of pipe. The pipe is now bundled and tagged; or in the cases of sizes 2″ and over, is stencilled with the tester's mark and the length. Professor R. T. Stewart, of the University of Pittsburgh, has found by tests that butt weld wrought iron pipe is 70% as strong as similar butt weld steel pipe, and that lap weld wrought iron pipe is only 57% as strong as similar lap weld steel pipe. In steel, the butt weld averages 73% of the tensile strength, and the lap weld 92% of the tensile strength of the material.

Developments in the manufacture of modern steel pipe have chiefly been along the lines of increasing the durability of the finished product. Such successful rolling processes as the "Spellerizing Process," invented by F. N. Speller, Metallurgical Engineer of the National Tube Company, have densified the metal causing it to be less susceptible to corrosion in the form of pitting. Other processes now being experimented with lead the writer to believe that the day is not far off when steel pipe of the best make will be very much superior in durability to the best makes of wrought iron.

Bibliography

Proceedings of Engineer's Society of Western Pennsylvania, 1907.

T. N. Thompson, two reports, 1908–10, American Society of Heating and Ventilating Engineers.

American Society for Testing Materials, 1906, 1908, (Howe).

"Corrosion of Iron." A. Sang, (McGraw-Hill Publishing Co.) (Extensive bibliographs.)

"Corrosion and Preservation of Iron and Steel," A. S. Cushman and H. A. Gardner, (McGraw-Hill Publishing Co.)

"Metallurgy of Iron and Steel," Bradley Stoughton.

"Electrolytic Theory of the Corrosion of Iron and Its Applications," Wm. H. Walker, (Journal Iron and Steel Institute, 1909).

"Function of Oxygen in the Corrosion of Metals," Wm. H. Walker, (Transactions American Electrochemical Society, Vol. 14 p. 175).

"Corrosion of Iron and Steel," by J. N. Friend, 1911. (Longmans, Green & Co.).

"Corrosion of Boiler Tubes," Journal American Society Naval Engineers, May 1904.

National Tube Company Pipe Bulletins.

"Corrosion of Iron," by L. C. Wilson.

"Prevention of Corrosion in Pipe," by F. N. Speller, Metallurgical Engineer, National Tube Co.

Data on File at Research Laboratory, National Works, National Tube Co., McKeesport, Pa.

WELL DRIVING WITH THE HYDRAULIC ROTARY

H. W. FLETCHER

The rotary method of drilling wells was in use many years ago, but it was not until 1901 that the process was sufficiently developed to make the rotary a serious competitor of the cable tool rig.

The discovery of oil in the coastal plains of Texas and Louisiana attracted operators from all over the world and it is safe to say that every well driving machine known, was tried here in the attempt to penetrate the thousands of feet of clay, sand and rock overlying the oil strata.

Previous to 1901, practically all oil wells were driven with the cable tool rig, which is nothing but an overgrown churn drill. A string of tools weighing several tons and carrying a tool steel bit with chisel edge is raised a few feet and dropped in the hole by means of a cable and walking beam operated by a steam engine.

Water is fed to the bit and mixes with the sand and pulverized rock to form a mud. After several hours of drilling the tools are hauled out and the mud is removed with a bailer. A new sharp bit is then attached to the string of tools, let down into the hole, and drilling is continued.

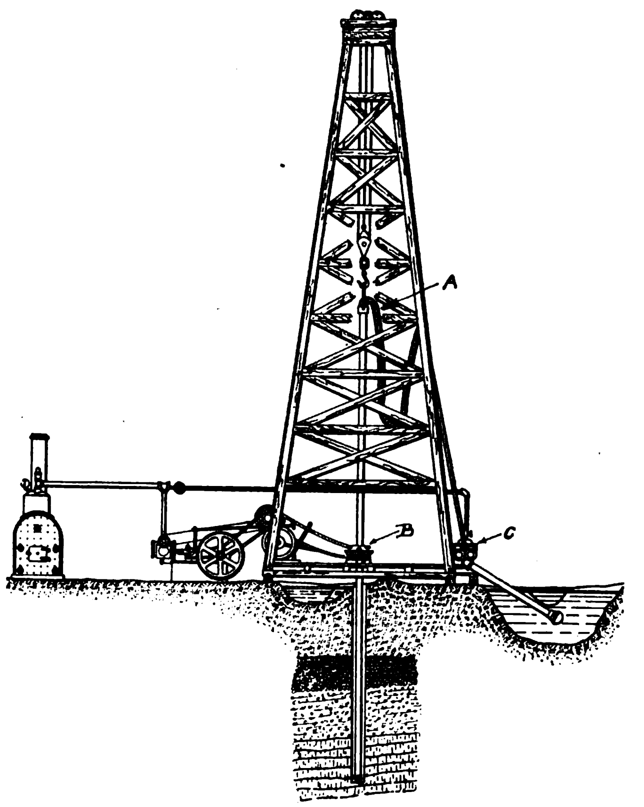


FIG. 1

The churning action of the bit tends to wash out the walls of the hole and cause cave-ins that are apt to stick the tool and break the cable. For this reason it has been found necessary to follow up after the bit with a

FIG. 2. FISH TAIL BIT

string of pipe, called a casing, which is slipped into the hole as far as it can be carried. When the casing sticks, it is necessary to go down inside it with a smaller line, a deep well frequently requiring five or six strings.

The quick-sands and sticky clay encountered in the southern fields proved an insuperable obstacle to the use of the cable tool principle, and attention was turned to the rotary rig illustrated in figure 1.

A string of pipe is supported by a swivel "A," from a derrick in such a manner that it can be raised or lowered at will. The drill pipe passes down through a rotable table "B," which grips the pipe in such a way as to rotate it while still permitting free up and down motion. Water is taken from a sump by a steam pump "C," and is fed into the drill pipe under pressure through the swivel.

On the lower end of the drill stem is fastened the bit usually of the fish tail type illustrated in cut 2.

In operation, the rotary is run at about 60 to 100 R. P. M. by means of a steam engine, and the pipe is slowly fed down by releasing the brake on the hoisting

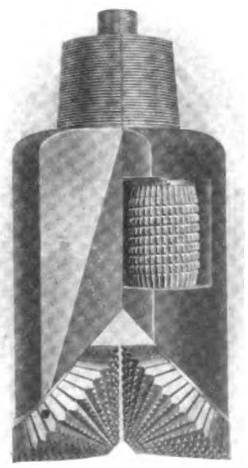


FIG. 3. CONE BIT

FIG. 4. REAMING CONE BIT

drum. The material churned up by the bit mixes with the wash water to form a mud that rises between the drill pipe and the wall of the hole and overflows the top into the sump, where the solid particles settle out and the water is recovered.

When porous strata are encountered, clay is mixed with the water in the sump and is pumped down through the bit, where it plasters up the porous section and prevents loss of water. As may be imagined, this is hard on the working parts of the pump, but in some localities is very necessary.

In soft formations remarkable speed has been made with the rotary, as much as one thousand feet of hole having been sunk in thirty-six hours; but, as would be expected, drilling rock with this outfit is a very slow and laborious process.

Try to drill a piece of sand-stone with a twist drill and you will have some idea of the difficulties involved. Then imagine that twist drill several thousand feet deep in the earth, attached to a flexible string of pipe, and you will have some idea of what it means to drill rock with a fish tail bit.

To meet the need for an efficient rotary rock tool, the bit illustrated in figures 3 and 4 was invented and developed by Mr. Howard R. Hughes, of Houston, Texas, about 1907. Although a rotary tool, this bit really cuts by percussion, and not by scraping. The two cones roll in a circle about the center of the hole, and each tooth, as it strikes the rock, crushes out a flake of material that is immediately carried up by the wash-water and floated out of the hole.

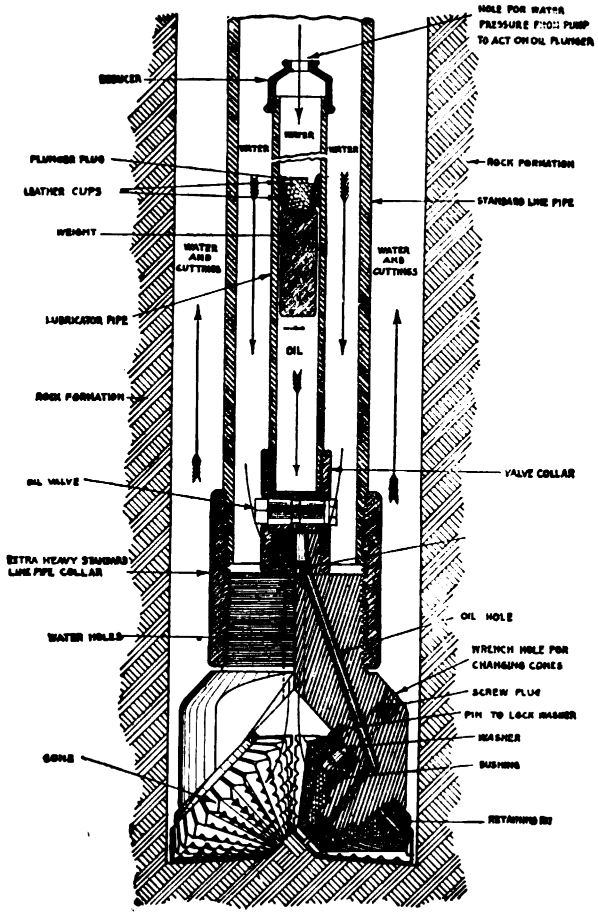
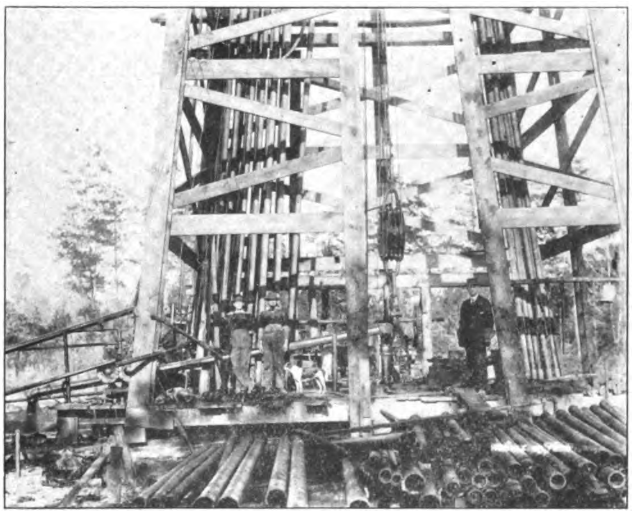


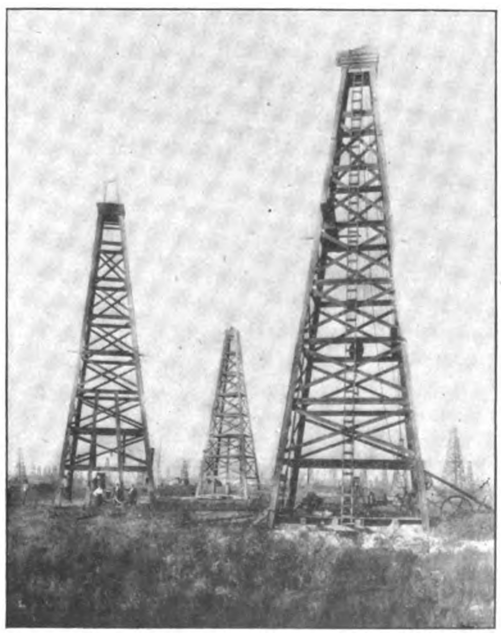
FIG 5. CONE BIT SHOWING METHOD OF LUBRICATING

Figure number 5 shows the construction and method of operating the rock bit. The cones are fastened to the head by means of bronze bushings and retaining rings. A continuous stream of oil is forced thru the bushings by the weighted plunger in the lubricator pipe and keeps the bearing free from grit. This forced lubrication, coupled with the fact that the stream of water playing on the cones keeps the temperature fairly uniform, has made it possible to carry bearing pressures of 3000 pounds per square inch, and over; though, of course, the bushings wear appreciably under such a load.

As to speed—one foot an hour can be drilled in average hard rock, any size hole, and five feet is the rule rather than the exception. Moreover, the hole will not taper off because of wear on the cutting edges as much as it will where the fish tail is used, there being prac-



OIL WELL



OIL FIELD

tically no taper when the type of bit shown in Figure 5 is used, where the small rollers in the head bring the bore up to gauge when the cones begin to show wear.

This cone bit cuts much more rapidly than the fish tail, which will often wear off as fast as it makes hole, and which, in some kinds of rock will not drill at all. It is moreover also a time-saver, in that it will drill from 50 to 150 feet of hard rock before the cones wear out; thereby greatly reducing the number of times it is necessary to pull out the string of pipe. It is no small matter to hoist and uncouple 2000 feet of eight inch drill pipe and a reduction in the number of "pulls" means an appreciable saving of time and money.

Well, when the bit finally gets down into the oil sand, traces of oil begin to appear in the wash water, and the character of the cuttings changes till finally the experienced driller knows that it is time to set his last string of casing and bring the well in.

A strainer, very similar to that used on the drive pipe of the common lift pump, is sent down and set in the oil sand, and a gate valve is put on the upper end of the casing to control the flow of oil. Sometimes the pressure of oil and gas is sufficient at this point to blow the mud and water out of the casing and again it may be necessary to bail until the well gushes. Once a flow of oil is started it is piped off from the casing and run into a large earthen tank, lined with clay.

Here the oil and water are separated out by gravity, the water being run off from the bottom of the tank through a valve-controlled waste pipe, and the oil pumped to one of the many steel storage tanks, from where it is piped down to the tank ships.

Of course a large percentage of the wells drilled fail to strike oil, but there is always the chance of bringing in a gusher to lure the operator on, and wild cat wells (i. e. wells driven in unproven territory) are being put down continually.

The comparatively new field at Goose Creek, Texas, in particular, is being rapidly developed, and gives promise of becoming one of the great fields in the country, if not in the world.

The high price of oil, which will probably be maintained by the increased consumption of petroleum products in all lines, has done much to stimulate production and the next few years should see a substantial expansion in all branches of the oil industry.

ENGINEERING ABSTRACTS

Six Years' Development of the Werkspoor Marine Diesel Engine. By Thos. O. Lisle. Journal A. S. M. E., March, 1917.

This is a very interesting paper which gives much valuable information to those interested in Marine Diesels. This information has been obtained by the experience of this Amsterdam firm, which has now equipped twenty-four sea-going mercantile ships with their engines.

The first point of interest is that this firm has built nothing but four-stroke cycle engines and the author of the paper is certain that this type is superior to the two-stroke cycle.

This firm introduced in 1910 the Diesel engine having short pistons, crossheads and guides and their experience since that time has been favorable to this type. It is now the custom of this company to install these engines without any shop test, but give them about a three hours' run at the wharf and about four hours at sea.

Their early experience showed the need for very effetve cooling of the piston and all of the combustion chamber, as well as the desirability of making the design so that the pistons may be easily taken out for cleaning. With heavy oils the piston rings are likely to become gummed and stick. With their design the piston can be dismounted, rings replaced and the pistons are mounted in about one and one-half hours.

The frames of these engines consist of forged steel columns, stiffened by diagonal steel rods. This open-column construction has been used since 1912 and has been entirely successful.

They have found that sea water may be used for cooling the cylinder pistons and bearings, providing extreme care is exercised in designing the water space so that no pockets exist. With sea water below 70° F. it is claimed to be as good as fresh water for cooling purposes, and if it is below 100° F. practically no scale is deposited.

As a result of some crank-shaft failures of engines built by this company and others the size of bearings has lately been increased and forced lubrication introduced, while for certain vessels now building, built-up crank shafts are being used.

Reversing is accomplished rapidly and quietly by using two camshafts, one for the ahead running and the other for the astern movement. A 1000 h. p. engine may be reversed from full ahead to astern in from 5 to 10 seconds.

Instead of using a separate fuel pump for each cylinder this company prefers the use of a single pump which furnishes the fuel to distributing boxes, each of which feeds three cylinders.

The exhaust gases are used to make steam in a donkey boiler, which of course, must have a very large amount of heating surface due to the fact that the exhaust gases leave the engine with temperatures of from 700 to 800° F. During the daytime there is sufficient steam furnished by the heat from the exhaust gases to operate the pumps and steering gear, but at night the additional steam required by the lighting dynamo is furnished by an oil-fired boiler.

(*Continued on page 12 ad.*)

(Continued from page 200)

For the smaller engines, say from 200 to 500 h. p. running at 160 to 200 r. p. m. this company has designed a reversing-blade propeller, which they believe to be able to do the heavy duty demanded of it.

These reversing propellers are entirely different from the usual type inasmuch as they are very carefully designed and constructed and are actuated by power furnished by the engine itself. They are considered to be of particular advantage in such cases as that of harbor tugs, in which reversals of one hundred per hour may be necessary. In such cases the ordinary type of reversing engine might be stalled by lack of starting air.

In closing the author states that his opinion is, "That in six or seven years every new cargo ship of under 10000 tons displacement will be equipped with internal combustion motors of the crude-oil type, except in rare instances where special circumstances of service will cause steam engines to be the only suitable machinery. The advantage of the Diesel type engine will be appreciated most during normal times. When low freight rates return, it will not be possible for steamers to compete with motor ships on many routes, particularly where long distances have to be covered, and especially where tramps are concerned. In hard times shipowners will be forced to use the most economical propulsion. Other methods of steam power cannot be made as efficient and as economical as the crude-oil engine, unless the price of oil should rise to phenomenal figures.'.

F. O. E.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI JUNE, 1917 No. 9

THE SIBLEY JOURNAL OF ENGINEERING

SIBLEY COLLEGE, CORNELL UNIVERSITY

Editor—J. C. FRIEDRICH

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:
United States, Mexico and Canada, $2.00 a year
Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 5th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR JUNE, 1917

We Need More Co-operation

We wish to take this opportunity to remind our readers that one of the main objects of THE SIBLEY JOURNAL OF ENGINEERING is to be a medium of exchange for worth-while ideas in the engineering field. We believe that it would be better for THE JOURNAL to have more co-operation on the part of its readers, and especially is this true of the Sibley alumni who are holding responsible positions in the engineering world and of those who are successfully carrying out research work. We feel that our paper is not in close enough touch with the alumni of Sibley College, and that a good way for it to come into a closer touch with them, is for them to make the JOURNAL an exchange of the above mentioned worth-while ideas. We can safely assert that if THE SIBLEY JOURNAL does take this hold in their interests, it will be of more instructive value than ever before. We have published articles of excellent character, but the alumni as a whole have not taken the interest we would have them take in their paper. At all times we are open to suggestions and criticisms; and, in fact, we want them very much.

Men are leaving the University in large numbers. Sibley College is losing its share. About three hundred Sibleyites have already left, and among these are counted members of THE SIBLEY JOURNAL Board. It is evident, therefore, that to carry THE JOURNAL successfully through the period of this war, we must have more co-operation than ever on the part of the alumni. We realize, too, that the alumni are having about all they can take care of at the present time, and for this reason we wish again to impress on them the necessity of their co-operation with THE JOURNAL.

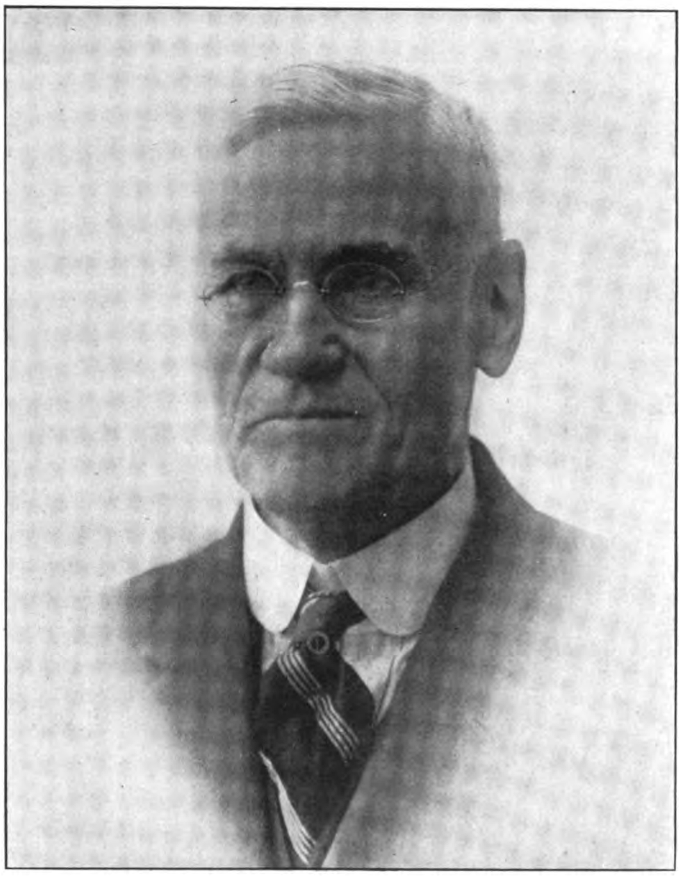
The whole thing resolves itself into this; that it is our most earnest desire to place THE SIBLEY JOURNAL OF ENGINEERING in the top rank of engineering technical publications. Remembering that this paper belongs to Sibley men and is not run for selfish purposes, we ask the alumni and any other persons interested in our publication to help us out, and especially do we ask for this assistance as long as the war lasts.

The Directory Number

A summer number of THE JOURNAL is to be a directory of all the Sibley alumni. We want correct information immediately of every alumnus in order to make the directory accurate to date. Last year this issue proved a success, and this year we wish it to be even a better one. The one way to do this is to have every alumnus see that we have his own data correct. Every Sibley graduate must do his share for this issue to make it mutually beneficial to himself and to his fellow alumni.

ROLLA C. CARPENTER

Professor Rolla C. Carpenter, who has been a prominent member of the faculty of Sibley College ever since 1890, will retire from active service at the close of the present term. Professor Carpenter is enjoying his usual health and will continue to be active in the engineering profession particularly along the lines of coke manufacture and the recovery of by-products incident to that industry.



Professor Carpenter was born near Orion, Michigan, June 26, 1852. His father, Charles K. Carpenter, owned an extensive farm at this place and was also vice-president of a railroad running between Detroit and Bay City which now forms part of the Michigan Central system. Professor Carpenter was one of a family of seven children of which six are living. He received his early education in the district school and in the Pontiac High School, then entered the Michigan Agricultural College from which he received the degree of Bachelor of Science in 1873. He received the degree of Civil Engineer from the University of Michigan in 1875. He was then engaged as an instructor in the Michigan Agricultural College, at the same time doing graduate work, and received the degree of Master of Science in 1876. He was married to Miss Marion Dewey at Greenville, Michigan, May 25, 1876. In 1878, he was elected professor of mathematics and civil engineering at the Michigan Agricultural College, which position he held until 1890. During part of this period he spent his vacations, which then came in the winter months, studying at other institutions. Part of this time was spent at Massachusetts Institute of Technology, where he studied under Professors Peabody and Lanza, and part was spent at Cornell where he received the degree of Master of Mechanical Engineering in 1888. He was greatly assisted in the preparation of his thesis for the M.M.E. degree by his connection with the Lansing Iron and Engine Company of Lansing, Michigan, as consulting engineer. This connection placed at his disposal the facilities of a large and up-to-date manufacturing plant which offered opportunities not then enjoyed by any of the technical schools. This thesis, which is now on file in the University library and which was reported upon by Dr. Thurston in a paper read before the American Society of Mechanical Engineers, was on the subject of Internal Friction in Non-condensing Engines and, as shown by Dr. Thurston's discussion, played an important part in the entire revision of the then prevalent ideas about steam engine friction.

In 1890, Professor Carpenter was elected Associate Professor of Engineering at Cornell University and the laboratory work was organized as a separate department under his direction. In 1895, he was elected Professor of experimental engineering, which position he has held ever since. Professor Carpenter's first office at Sibley was located in the southeast corner of the laboratory building which is now the materials heat treatment room.

A year or two prior to Professor Carpenter's official connection with Sibley College, the present mechanical laboratory building was completed. The ground floor was devoted to laboratory work which was then under the direction of Dean A. W. Smith who, was Professor of machine design, and he was assisted by G. W. Bissell, now dean of engineering at the Michigan Agricultural College. The second floor of the building was occupied by the drawing department. The extension on the east end, the first floor of which is now occupied by the fireman and the second floor as a recitation and computing room was added later. The equipment of the laboratory at this time was by no means poor, some of the apparatus being: a "Straight Line Engine," two Payne simple engines, one of which is still in use, two "standard" and one "railroad" Thurston oil testing machines, a transverse

testing machine, two 10,000 lb. hand testing machines, a Thurston torsion testing machine, a steam engine indicator, and other small apparatus.

Professor Carpenter's experience in the several leading educational institutions as well as his intimate contact with various industrial enterprises peculiarly fitted him for the work of building up a course of instruction in experimental engineering which has done much for the upbuilding of the reputation of Sibley College and which is regarded by many alumni as furnishing a most valuable part of their education.

This system has been copied with some modifications in many other colleges and technical schools and has no doubt had a pronounced influence upon the methods of teaching other sciences.

The great expansion of the mechanical laboratory during the next five years is shown by a description of the apparatus written in 1895. This includes most of the present laboratory equipment with the exception of the more modern gas and oil engines, the refrigerating machines, the electric dynamometer and some minor apparatus. There was also at that time a large assortment of apparatus which has since been discarded or become antiquated.

Professor Carpenter published his "Notes on Mechanical Laboratory Practice" in 1891. This was the basis of his later text book on "Experimental Engineering" which has been the leading manual in this country on the subject. The first edition of his book on heating and ventilation was published in 1895 entitled "Heating and Ventilating Buildings." This book has gone through six revisions and has had an extensive circulation. It contains much original material from the author's own experience and is much quoted by later writers on heating and ventilating. Professor Carpenter is also joint author with Professor Diederichs of a text book on "Gas Engines." In addition to these books, he has made many contributions to engineering literature through various societies and publications, among which may be mentioned the American Society of Mechanical Engineers, the American Society of Civil Engineers, and the American Society of Heating and Ventilating Engineers. He has been a frequent contributor to THE SIBLEY JOURNAL, of which he has been an associate editor from the time he first became officially connected with Cornell.

Professor Carpenter holds membership in eight of the leading engineering societies of America. He was vice-president of the American Society of Mechanical Engineers from 1908–11 and has served on various committees of this society, perhaps the most important of which is the Boiler Code committee. He was president of the American Society of Heating and Ventilating Engineers in 1898, was vice-president of the American Society of Automobile Engineers in 1910–12 and has taken an active interest in the student branch of the American Society of Mechanical Engineers at Cornell. He is a member of the Delta Tau Delta, the Tau Beta Pi and the Masonic fraternities. He is also active in social affairs being a member of the Engineers' Club of New York City, the New York Railroad Club, the Town and Gown Club of Ithaca and the Alpha chapter of the Sigma Xi of which he was president in 1912–13.

Professor Carpenter has engaged in a diversified field of investigation and research including problems relating to power plants, gas engines, cement manufacture, coke manufacture, railway management, heating and ventilating, etc. He is one of the greatest patent experts in the country and has been employed by many of the leading law firms in various parts of the United States. He has invented a number of pieces of laboratory apparatus, such as the Carpenter coal calorimeter, which was for many years a standard for testing the heating value of coal, the throttling and separating steam calorimeters now extensively used, a friction testing machine which may be found in most of the large laboratories and an inertia governor for the steam engine.

His life has been brimful of activity. During the earlier days when the contact of the student with the department heads was much more intimate than it now is the students under Professor Carpenter were inspired with his spirit of leadership and enthusiasm and although the work required in the laboratory was often greatly in excess of the credits received, there was seldom complaint and the students leaving the university carried this spirit of enthusiasm out into the world which has, no doubt, helped to stamp the Sibley graduates as successful engineers and business men.

Professor Carpenter has been honored by appointment to various positions of distinction. He was judge of machinery and transportation at the Chicago Exposition in 1893, at the Buffalo Exposition in 1901, and at the Jamestown Exposition in 1907. He was a member of the commission appointed by the Academy of Science in 1915 at the request of the President of the United States to investigate the slides at the Panama Canal and to make such recommendations as in the judgment of the commission would improve the conditions and lessen the possibilities of slides in the future. He received the degree of Doctor of Laws in 1907 from the Michigan Agricultural College.

Professor Carpenter's kindly manner and genial disposition make it easy for even the most timid to approach him and he is never too busy to be considerate of anyone who may seek his council and advice. His large and varied experience, coupled with good judgment and his extensive knowledge of the engineering profession and of human nature, make his council and advice exceedingly valuable to his colleagues as well as to students and the world at large.

PORTLAND CEMENT

G. A. RANKIN

Portland cement is the finely pulverized product of several chemical compounds which result from partial fusion of an intimate mixture of properly-proportioned argillaceous and calcareous materials. When the fine powder is mixed with water a hard stone-like mass is formed. The mortar thus obtained with portland cement is far superior in strength and durability to any of the other various types of mortars commonly used in construction. This is due to the fact that portland cement, which is the only cement formed by the partial fusion of the raw materials, contains a compound known as tricalcic silicate, which is only formed at extremely high temperatures. The value of employing high temperatures in the manufacture of cement was discovered about one hundred years ago; it is only in recent years, however, that the process for the manufacture of portland cement has been sufficiently developed so as to produce a uniform product on a large scale.

The early investigations which ultimately led to the production of cement containing tricalcic silicate may be said to have started from the desire of engineers to obtain a satisfactory cement which would harden under water. In order to discover such a cement, two distinct modes of attack were employed: the one, representative of the first investigations in England, was to proceed by more or less "hit-and-miss" methods to the determination of the proper substances to be used and of the methods employed for the manufacture of an hydraulic cement; the other mode of attack, which originated in France, was to proceed in a systematic manner and to make use of the knowledge of the chemistry of the substances available for such a cement.

While it is not our present purpose to take up an extended discussion of the relative merits of these two types of cement investigation, it may be well to give a brief account of the most important early investigations of each type; taking up first the researches carried on in England and then those of M. V cat in France.

The cement industry may be said to have started in 1756 from the researches of John Smeaton, an English engineer. Smeaton had been employed by parliament to build a lighthouse upon a group of partially exposed rocks in the English channel. Two wooden structures had previously been built and each had experienced a comparatively short life. When Smeaton attacked the problem, he determined to build a structure which would weather the fiercest storms of the channel. One of the greatest difficulties he had to overcome was the failure of ordinary lime mortar to harden under water. In order that his foundations be firm it was necessary that some mortar be found which would meet this difficulty. To this end he undertook a series of investigations of lime mortars, the result of which was the discovery that a clayey limestone when burned produced a mortar which would not only harden better in air than ordinary lime but would also harden under water. Such a clayey limestone Smeaton found in Cornwall and he made hydraulic lime by burning this stone. This hydraulic lime when mixed with puzzalona, a pumice-like material of volcanic origin, produced a satisfactory mortar which Smeaton used in the construction of the Eddystone lighthouse. This cement of Smeaton's, while it was undoubtedly an excellent structural material, has never been widely used, for the reason that puzzalona is only found in a few volcanic regions, notably Italy, where it was previously used in the making of the famous old Roman cements.

This circumstance, that puzzalona was not found in England, led to further investigations to determine the possibility of making a satisfactory water cement without this ingredient. As a result of these investigations various processes for the manufacture of artificial Roman cements were patented. These so-called cements were really hydraulic limes, similar to that prepared by Smeaton, tho they were made by burning limestone containing a rather higher percentage of clay. It was from one of these hydraulic limes, patented in 1825 by Joseph Aspdin, an English bricklayer, that portland cement derives its name. Aspdin took out a patent for the manufacture of an improved cement which he called portland cement from its resemblance in appearance after hardening to portland stone, a famous English building stone. This cement was made by heating together an intimate mixture of limestone and clay to a temperature sufficient to expel the carbon dioxide. The process thus described is incapable of producing a cement such as is now known as portland cement, the temperature of burning not being sufficiently high for the formation of the essential constituent, tricalcium silicate. It was not long, however, before this defect became obvious, the value of burning to a temperature of incipient fusion being discovered in 1825. While the superiority of the cements thus made by partial fusion of the raw materials was soon recognized, the knowledge of why fusion is essential has but recently been discovered. We now know that it is tricalcium silicate which imparts to portland cement its most valuable properties and that it requires extremely high temperatures in order that this compound be formed from limestone and clay. In spite of this lack of scientific knowledge during the early stages of the development of the portland cement industry in England, the proper proportions of limestone and clay to be used were discovered by burning various mixtures and testing the physical properties of the cements thus obtained.

The scientific knowledge of the chemistry of cements resulted from the various investigations carried on in France. Of these early researches the most important are undoubtedly those of M. Vicat, who undertook to

straighten out the chaos of opinions and opposing facts regarding cements which existed at the time he started his work in 1812. Without taking up the exact nature of the chaotic conditions, it may be briefly stated that Vicat made an attempt to determine the relation between the quality of hydraulic lime and cement and the chemical composition of the stone whence they are derived; the nature of the chemical compounds formed during burning; and the changes which take place when the cement is mixed with water and hardens.

While he did not entirely accomplish his purpose, Vicat did evolve some very interesting theories as to the hardening of calcareous mortar and cements.

These theories of cement making, which one must infer Vicat had in mind tho he embodied them in no simple direct statement, are: (1) that the lime contained in cement mortars should be present in chemical combination with some material other than water; (2) that this other material should be silica, preferably in a finely divided or gelatinous condition.

Later in this paper, after having presented our present knowledge of the constitution of portland cement and of the chemistry of the hardening of mortar, an attempt will be made to show that Vicat's theories not only explain in a measure the essential active principle of the hardening of portland cement mortar but also indicate that it should be possible to produce a cement which will in turn produce a mortar of much greater strength and durability.

While Vicat in France was working out these theories as to the best cement practice, the English, with little or no theoretical knowledge (more by luck than otherwise), discovered a process for the production of an hydraulic cement far superior to any then produced in France. This discovery, of which a brief account has already been given, was, from one point of view rather unfortunate, for the reason that this chance discovery produced a cement (portland cement) so far superior to any previously known that apparently the idea prevailed—and to some extent still does prevail—that there is no possibility of producing a still better cement. It would appear that this minimized to some extent the recognition of the value of theoretical cement investigation, since but little of value was undertaken for some time after Vicat's investigations.

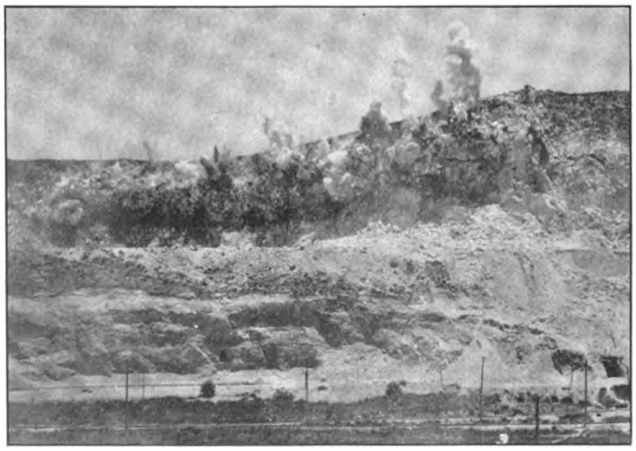


FIG. 1. CEMENT ROCK QUARRY, SHOWING METHOD OF KNOCKING DOWN ROCK BY BLASTING

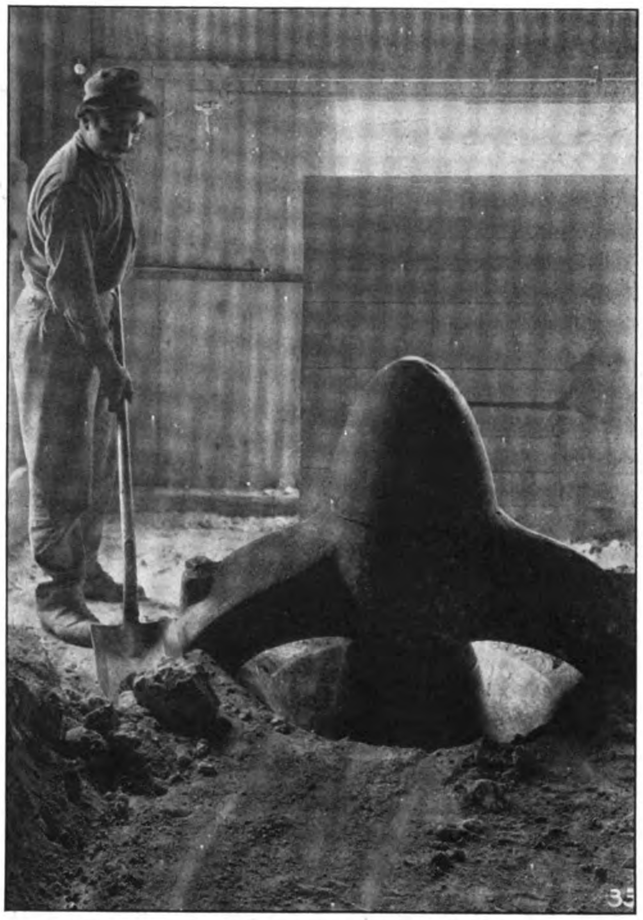


FIG. 2. CRUSHER USED TO BREAK UP CEMENT ROCK AS IT COMES FROM THE QUARRY

In spite of this fact, however, that but little has been known of the theoretical possibilities involved in the chemistry of the process, the many improvements in the merely mechanical part of the process have made possible the production of better and more uniform product than was first made.

At first the English and later the German process produced cement which was the standard of quality: to-day, however, the best portland cement is undoubtedly made in America. This has been brought about by improvements in the mechanical appliances of the industry which have been developed largely in this country and which, as we now know, have gradually increased the percentage of tricalcic silicate in cement, by affording more favorable conditions for the formation of this compound.

American portland cement is ordinarily prepared by heating together a mixture of the two raw materials, one composed largely of calcium carbonate, the other of aluminium silicates. The most typical materials answering to this description are limestone and clay, both of which occur in nature in great quantities and in a number of varieties; other materials sometimes used are blast furnace slag with limestone. Any combination of raw materials containing lime, alumina and silica—the essential components—in the proper proportions may be used, however.

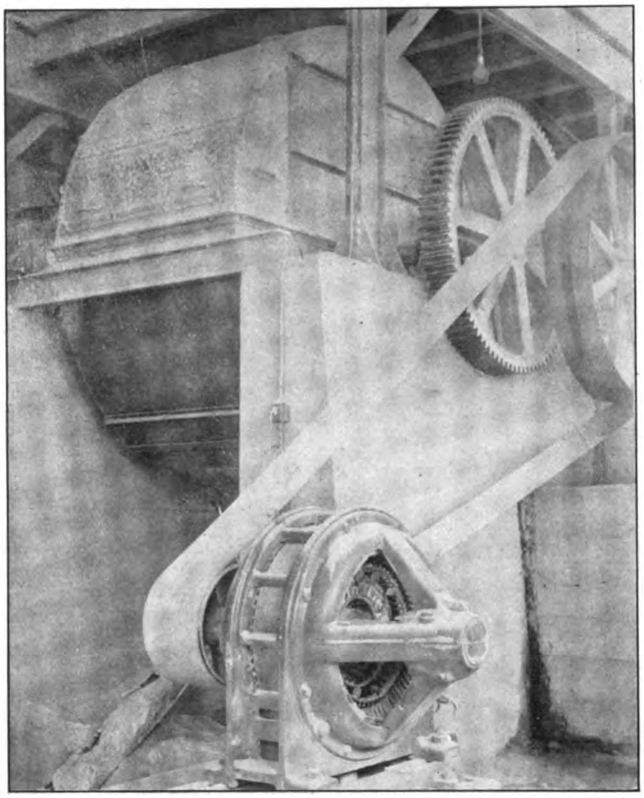


Fig. 3. Ball Mill for Mixing and Grinding Crushed Cement Materials

Briefly outlined, the method commonly used in America for the manufacture of portland cement is as follows: The raw materials—namely, limestone and clay, or their equiavlents—are crushed and dried, in order to insure satisfactory grinding and mixing; they are then mixed in the desired proportions, as indicated by previous chemical analysis, ground together until the whole of the material is reduced to very fine powder, and burned. The burning is carried out in a rotary kiln, the action of which is continuous, the raw material entering at one end and the cement clinker passing out at the other. These kilns are cylindrical, ranging from 60 to 150 feet in length and 5 to 8 feet in diameter, and are built up of steel plates lined with highly refractory material; they are supported in a slightly inclined position by friction rollers and are slowly rotated. The fuel commonly used is bituminous coal which, after being thoroughly dried and powdered, is blown by compressed air into the lower end of the kiln, thus securing very thorough combustion. This arrangement insures the maintenance of a high temperature at the lower end of the kiln, so that the raw material passing down encounters a continually increasing temperature. The changes taking place in the progress of the material through the kiln may be divided into three stages: in the first the material is thoroughly dried, in the second all organic matter is destroyed and the carbon dioxide of the calcium carbonate is expelled, while the third is the chemical reaction between the lime, alumina and silica to form the clinker. The time of passage through the kiln is about one and one-half hours and the final temperature is about 1425° C. The clinker, in the form of granules varying in size from that of a pea to that of a large marble, is a partially fused mass of the chemical substances formed by the reactions occurring in the third stage: when ground to a fine powder, it constitutes the portland cement of com-

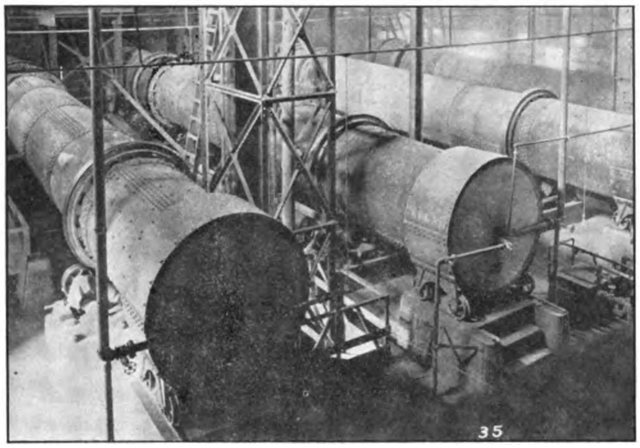


Fig. 4. Rotary Kiln in Which Cement Materials are Burned

merce. It is usual, however, to mix with the clinker, before it is ground, a small proportion of gypsum, the purpose of which is to regulate the time of setting of the cement when mixed with water.

It has just been stated that portland cement clinker is the result of chemical combination of the three oxides, lime, alumina, silica; but beside these three which are the essential components—two others, namely, magnesia and ferric oxide, always occur to some extent in commercial cement. The average of a large number of chemical analyses of American-made portland cement is, according to Meade,

CaO	62.0 per cent.	Fe_2O_3	2.5 per cent.
Al_2O_3	7.5 per cent.	MgO	2.5 per cent.
SiO_2	22.0 per cent.	SO_3	1.5 per cent.

From this it is evident that more than 90 per cent. of an average Portland cement consists of the three oxides, CaO, Al_2O_3, SiO_2: one would expect, therefore, that its properties are due mainly to the presence of the above three components and that the relatively small admixture of the other oxides exerts at most a wholly

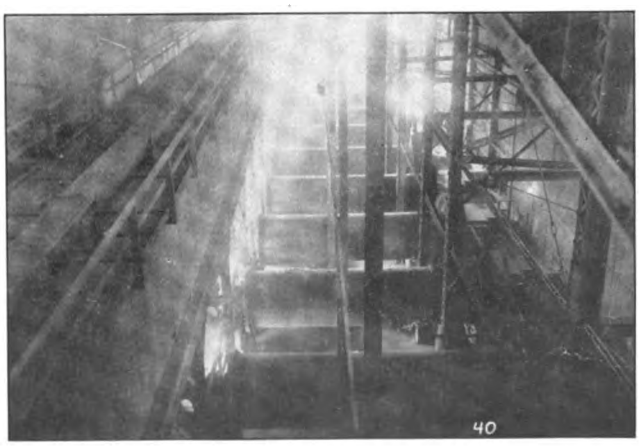


Fig. 5. Tube Mills in Which Cement Clinker is Ground

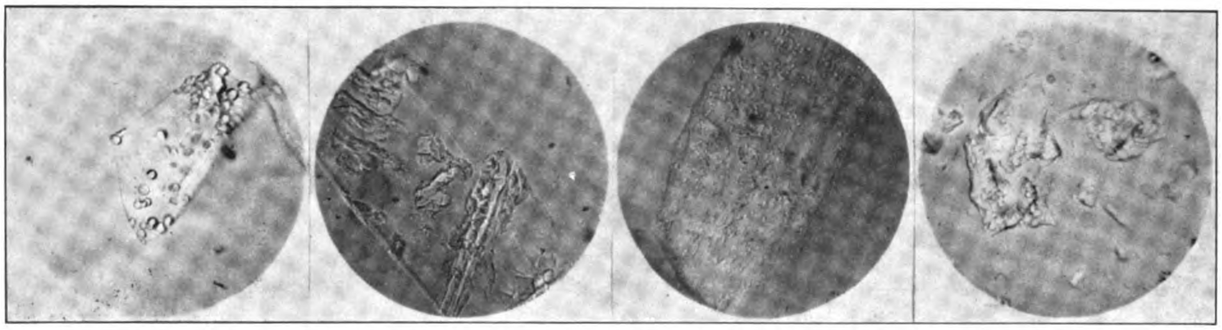
secondary influence. Indeed, it has been shown that good portland cement can be made from the three pure oxides, lime, alumina and silica, in the proper proportions.

The main constituents of portland cement clinker made up only of the oxides CaO, Al_2O_3, SiO_2 are the three compounds $3CaO.SiO_2$, $2CaO.SiO_2$ and $3CaO.Al_2O_3$. The compound $5CaO.3Al_2O_3$ and CaO are minor constituents. Each of these compounds has optical properties peculiar to itself which serve to distinguish it from the rest. The several characteristic optical and crystallographical properties were obtained by a study of each compound by itself. These values are constants for the individual compounds in all mixtures made up from pure CaO, Al_2O_3 and SiO_2; i. e., the final products resulting when such mixtures are heated, are present as individuals of constant optical properties and not as solid solutions.

Photomicrographs, to show each of these constituents as isolated crystals, are given in Figs. 6–12. These crystals, which are shown here as they occur imbedded in fragments of glass, were thus obtained by special methods for the purpose of microscopic study. It will be noticed that except for the $3CaO.SiO_2$ the other constituents obtained in this way do not show any definite crystalline outline but that they appear as more or less indistinct irregularly shaped grains in the fragments of glass. In spite of this, the fact that each of these grains is isolated in glass (surrounded by a medium of uniform optical character) enables one to determine its characteristic optical properties.

Figs. 6, 7, 8 represent crystals of lime, tricalcic aluminate and the compound $5CaO, 3Al_2O_3$, respectively, imbedded in fragments of glass. These three compounds are optically isotropic, so that it is not possible to show here the most characteristic distinguishing property of each of these compounds—namely, the value of its refractive index. Also, since they are isotropic, they are inactive toward polarized light and so photomicrographs taken with the nicols crossed show simply a black field.

Figs. 9 and 11 show crystals of dicalcic silicate and tricalcic silicate crystals, respectively, imbedded in fragments of glass. Figs. 10 and 12 are the same, except that the photomicrographs were taken with the nicols crossed. This shows something as to the action of polarized light toward these compounds dicalcic silicate and tricalcic silicate which are optically birefracting.



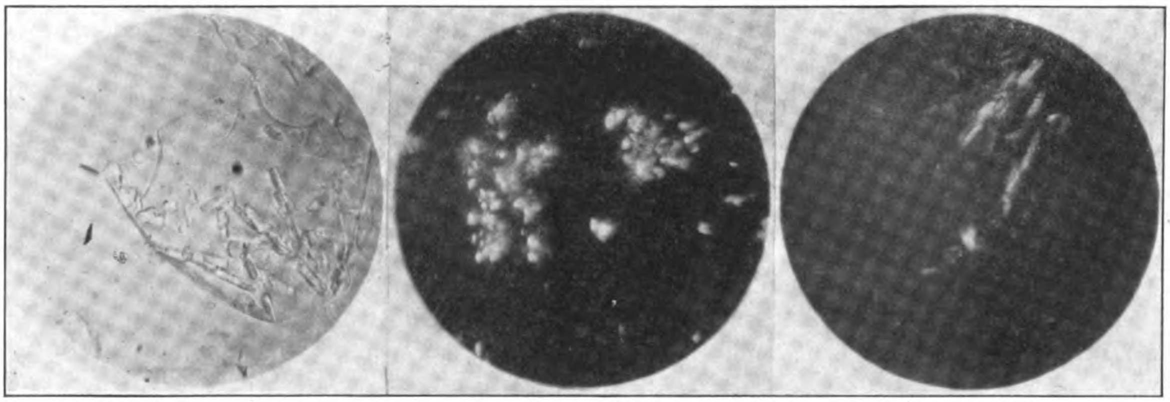
6 7 8 9

FIG. 6. PHOTOMICROGRAPH SHOWING CRYSTALS OF FREE LIME IMBEDDED IN GLASS. MAGNIFICATION, x 150.

FIG. 7. PHOTOMICROGRAPH SHOWING CRYSTALS OF TRICALCIC ALUMINATE IMBEDDED IN A FRAGMENT OF GLASS. MAGNIFICATION, x 150.

FIG. 8. PHOTOMICROGRAPH SHOWING CRYSTALS OF THE COMPOUND $5CaO.3Al_2O_3$ IMBEDDED IN A FRAGMENT OF GLASS. MAGNIFICATION, x 150.

FIG. 9. PHOTOMICROGRAPH SHOWING CRYSTALS OF DICALCIC SILICATE IMBEDDED IN FRAGMENTS OF GLASS. MAGNIFICATION x 150.



11 10 12

FIG. 10. PHOTOMICROGRAPH TAKEN WITH CROSSED NICOLS SHOWING CRYSTALS OF DICALCIC SILICATE IMBEDDED IN FRAGMENTS OF GLASS. MAGNIFICATION, x 150.

FIG. 11. PHOTOMICROGRAPH SHOWING CRYSTALS OF TRICALCIC SILICATE IMBEDDED IN A FRAGMENT OF GLASS. MAGNIFICATION, x 150

FIG. 12. PHOTOMICROGRAPH TAKEN WITH CROSSED NICOLS SHOWING CRYSTALS OF TRICALCIC SILICATE IMBEDDED IN A FRAGMENT OF GLASS. MAGNIFICATION, x 150.

It is not possible, however, to show photographically the exact difference in the birefringence of these two compounds, the birefringence of tricalcic silicate really being very weak as compared with that of dicalcic silicate. Having given this brief description of the optical chracteristics of the essential compounds which are found in portland cement clinker, let us consider the formation of these compounds during the burning of clinker made up only of CaO, Al_2O_3 and silica in the proper proportion.

These data, presented in a concise manner, are given in Table 1 which shows the constituents of portland cement present between rather definite temperature intervals during the burning of this clinker. This table requires no special discussion. It may be well to mention, however, that while free CaO is present at 1450° C. it will be entirely combined when the temperature reaches 1650° C.

TABLE 1

FORMATION OF CONSTITUENTS OF PORTLAND CEMENT DURING THE BURNING OF THE CLINKER COMPOSED ONLY OF CaO, Al_2O_3, SiO_2.

Raw Mix	1000°C	1000°—1335°	1335°—1450°	1450°—1650°	Cool Clinker
CaO (as $CaCO_3$)	CaO	CaO	CaO	CaO	$2CaO.SiO_2$
Al_2O_3	Al_2O_3	$5CaO.3Al_2O_3$	$3CaO.Al_2O_3$	$2CaO.SiO_2$	$3CaO.SiO_2$
SiO_2	SiO_2	$2CaO.SiO_2$	$2CaO.SiO_2$	$3CaO.SiO_2$	$3CaO.Al_2O_3$
		$3CaO.Al_2O_3$	$3CaO.SiO_2$	Flux	
			Flux		

This description and table showing the essential reactions which take place when cement made up only of CaO, Al_2O_3, SiO_2 is burned, applies equally well to commercial portland cement. In commercial cements, however, there is always present small amounts of Fe_2O_3, MgO, alkalies, etc. These minor components, which total less than 10 per cent. have but little effect on the major constituents of the clinker. During the burning of cement clinker, however, these minor components play an important part, since their presence ensures the formation of a flux at a much lower temperature, and thereby materially promotes the combination of CaO with Al_2O_3 and SiO_2. In the burning of portland cement clinker it is essential that the chemical reactions be carried practically to completion. In other words, it is essential that the clinker be almost "perfectly" burned. If this is not accomplished the resultant cement will contain an excess of free or uncombined lime which may cause disintegration when the cement is mixed with water and hardens.

Let us now consider what is known as to the cementing value of the constituents of portland cement, taking up first the changes which take place when portland cement is mixed with water and hardens.

When portland cement is finely pulverized and mixed with water, a hard mass is formed by chemical action between the water and the constituents of the cement. The first change undergone by the cement mortar in passing from a plastic to a solid state is called "setting," which requires not over a few hours. After the mortar has set there is a gradual increase in the strength of the mass, and the cement is said to "harden." It sometimes requires a year's time for a cement to acquire its full strength.

While there is still much to be learned as to the chemistry of the hardening of portland cement, sufficient data on the hydration of the individual major constituents have been obtained to enable us to account for this gradual hardening and increase in strength, and to indicate the relative value of these constituents as cementing materials.

Let us consider the hydration of the three major constituents $3CaO.Al_2O_3$, $3CaO.SiO_2$, $2CaO.SiO_2$ in the order named. When pure $3CaO.Al_2O_3$ is mixed with water an amorphous hydrated material is first formed. This material sets and hardens very rapidly. The compound $3CaO.SiO_2$ when mixed with water, also sets and hardens rather rapidly. In the case of this compound, as in the case for $3CaO.Al_2O_3$ the setting and hardening is due to the formation of an amorphous hydrated material on the individual grains which are thus cemented together. The extent of the hydration or the per cent. of amorphous material which each grain will yield depends upon the percentage of water used and the time. With a given percentage of water the amount of amorphous material formed from the compound $3CaO.Al_2O_3$ in a given time is much greater than for the compound $3CaO.SiO_2$, that is, the compound $3CaO.Al_2O_3$ reacts with water much more rapidly than the $3CaO.SiO_2$. The compound $2CaO.SiO_2$ reacts very slowly with water and it is only after a long period of time that sufficient amorphous hydrated material is formed to cement together the grains of this compound and so form a hard mass.

The amorphous hydrated material formed by the action of water on the constituents of cement, does in time, no doubt, crystallize to some extent. From the data available it would appear that the crystals formed are calcium hydrate and some crystalline hydrate derived from $3CaO.Al_2O_3$. Apparently no crystalline hydrate of the calcium silicates is formed.

From this brief description of the action of water on the constituents of portland cement, it will be seen that the setting and hardening of portland cement involves the formation of an amorphous hydrated material which subsequently partially crystallizes; that the initial set is probably due to the hydration of $3CaO.Al_2O_3$; that the hardness and cohesive strength at first are due to the cementing action of the amorphous material produced by the hydration of this aluminate and of the $3CaO.SiO_2$; and that the gradual increase in strength is due to further hydration of these two com-

pounds together with the hydration of the $2CaO.SiO_2$.

Of the three compounds which thus take part in the setting and hardening of portland cement, the $3CaO.SiO_2$ appears the best cementing constituent; that is, this compound is the only one of the three which when mixed with water will set and harden within a reasonable time to form a mass whose hardness and strength is comparable to portland cement. The compound $2CaO.SiO_2$ requires too long a time to set and harden, in order to be in itself a valuable cementing material. The compound $3CaO.Al_2O_3$ while it sets and hardens rapidly, is rather soluble in water and is not particularly durable or strong.

From this it would appear that the compound tricalcium silicate is **the** essential constituent of portland cement, consequently the higher its percentage the better the cement. Before discussing the nature of an investigation which might lead to the production of a cement containing a high percentage of this compound, however, let us briefly reconsider the theories of Vicat in order to show the similarity between what appears to have been the ideal cement of his mind and tricalcic silicate. Vicat, it will be remembered, seemed to believe that the lime in cement mortar should be in a state of chemical combination and that it were best that it should be so combined with gelatinous silica. When tricalcic silicate is mixed with water to form a mortar a gelatinous material is formed which is composed of hydrous lime and silica. Whether the lime and silica continue to be chemically combined or whether the gelatinous material is colloidal is still a matter of some uncertainty, altho it would appear that this material is colloidal. The similarity between Vicat's theoretical cement and tricalcic silicate is thus apparent.

The basis for Vicat's theoretical reasoning was undoubtedly derived from his observations on the action of hydrated lime when ground with water and puzzalona, a material which contains over 40 per cent. silica with smaller percentages of Al_2O_3, MgO, Fe_2O_3 and alkalies. This mixture, commonly known as Roman cement mortar, it would now appear sets and hardens in much the same manner as tricalcic silicate. In the case of Roman cement the formation of the gelatinous material which subsequently hardens being due to the action of lime water on the puzzalona. This action, however, is exceedingly slow and it requires a much longer time for the completion of the hardening in Roman cement mortar, than in mortar containing tricalcic silicate. This is undoubtedly due to the nature of the chemical combinations of silica in puzzalona which react with water much less readily to form gelatinous silica than is the case of the silica combined in tricalcic silicate. This circumstance, that gelatinous silica is formed with such readiness when tricalcic silicate is mixed with water, is probably the reason why this compound is such a valuable cementing material.

This foregoing discussion, which tends to prove that gelatinous silica is the most essential constituent of a cement mortar, is somewhat speculative. That such speculation is desirable is due to the fact that by formulating advance theories as to the probable outcome of an investigation one may sooner attain the end. It is essential, however, that theory and established fact be not confused.

With this in mind let us now consider certain possibilities which might increase the percentage of gelatinous silica in cement mortars. We know at the start in such an investigation that tricalcic silicate is probably the only compound containing silica in combination in such a manner that it is **readily** converted into gelatinous silica when mixed with water to form a mortar. Therefore, until some other compound is discovered in which the silica is combined in such a way that it is more readily available in the gelatinous state, the best way to increase its percentage in cement mortars is to increase the percentage of tricalcic silicate in cement clinker. Unfortunately this is difficult, altho there are several very interesting possibilities.

Pure tricalcic is formed by combination of lime and silica only with the greatest difficulty, the temperature of burning required, 1600° C. being too high for industrial practice. In order that this compound form readily and at a sufficiently low temperature so as to become a commercial possibility, it is necessary that some substance or substances other than lime and silica be present during the burning. These substances to be of such a nature that a low melting rather fluid flux is formed so as to facilitate the combination of lime and silica to form tricalcic silicate. At present this flux is to a large extent furnished by the low melting calcium aluminates in the clinker.

In conclusion, let us recapitulate the main points contained in this paper. The value of portland cement depends upon the fact that when finely powdered and mixed with water it forms a hard mass; and the strength and permanence of this mass depend upon the constituents of the cement. The major constituents are tricalcium silicate, dicalcium silicate and tricalcium aluminate. Of these constituents, the compound tricalcium silicate is the one which hardens and develops the greatest strength within a reasonable time. This most important constituent, which is the one formed with the greatest difficulty, makes up only about 30-35 per cent. of an average normal portland cement. It may be said, therefore, that the essential process for the manufacture of portland cement is the formation of this compound, and that any improvement in this process yielding an increased percentage of tricalcium silicate will increase the cementing value of portland cement.

Geophysical Laboratory,
Carnegie Institution of Washington,
Washington, D. C.

THE HUMAN ELEMENT IN INDUSTRY

GEORGE F. BLESSING*

"Problems in human engineering will receive during the coming years the same genius and attention which the nineteenth century gave the material forms of engineering * * * * A great field for industrial experimentation and statesmanship is opening up." Thos. A. Edison. This has been copied from the front page of a technical magazine lying on my desk before me as I write. Further reading conveys the information that this periodical is "Pioneer and Leader in the Science of Industrial Management, Twenty-sixth year of the Engineering Magazine." Thus one of our best known engineering magazines announces a change in name which its managers believed will better indicate its contents and the field of activity it expects to cover. Turning to the table of contents the first article noted is an editorial entitled "Needless and Senseless Labor Strikes"; next comes an article entitled "The New Profession of Handling Men," followed by one on "Choosing Employees by Test." Similar articles are sandwiched between those which deal with grinding machines, fuel problems, superheaters, and other technical subjects. This indicates a significant set of conditions and carries with it a meaning that the young engineer will do well to meditate and analyze. It points out almost dramatically a new field of immense importance that is now attracting the attention of engineers and industrial leaders. I refer to what Mr. Edison calls human engineering.

For the first time in modern history the human element is being considered the most important factor in industry, and is receiving its best constructive thought. During the early stages of our industrial life, the thought and energy of its leaders were directed toward the development of machines and materials. These were the fields in which opportunity beckoned the man seeking fame and fortune through the avenues of trade and industry. After the mechanical fields had been developed to the point where an increase in efficiency and productive capacity of the machines became problematic or at least more difficult, men turned to the mechanism of organization and finance. From this phase of industry it was but a step to seek the profits of the day from the waste products of yesterday.

In all this development the hope and ideal was to completely displace the human factor or to so minimize it in importance that it might be ignored. And yet in the face of such tendencies, of a sudden, and almost dramatically it dawned upon the engineer that if machines and mechanical equipment resisted his efforts to increased efficiency, human machines and equipment bearing directly on the human element offered an undeveloped field of wonderful possibilities. If material waste offered opportunity for profits, the human waste offered opportunities still greater. Harrington Emerson, the efficiency engineer, announced that in the institutions he and his associates had investigated the average man was working at 25 per cent of his possible efficiency. The late Frederick W. Taylor of Scientific Management fame, stated that the increase of output ranging from 50 to 500 per cent which he gained were principally the result of working with the human element. Gilbreath added his contribution, and men less prominent verified and duplicated the results of these pioneers. How such increases in human efficiency affect the wealth of the nation is almost beyond comprehension.

It has been estimated, from data secured by the National Civic Federation, that if the efficiency of the ten million workers whose earning capacity they investigated, could be raised from a 25 per cent to only a 50 per cent basis, a total increase of $35,560,000,000 would be added to the wealth of the United States with no increase in the price of the commodities produced. Of course this amount is a mere estimate, but even at that they are figures to conjure with. In order, however, to secure this increased efficiency, and this enormous wealth, you must have the right people, at the right work, under the right conditions at the right time. In this connection, it is stated that while only five per cent of the people are unusable, that it is a very small fraction of the remaining 95 per cent that are placed so as to work at their "most useful pitch of energy." Dr. Blackford, the employment expert, said that of 1,000 persons taken at random from her files 763, or 76.3 per cent, considered themselves in the wrong vocation. What such a hit-and-miss method of letting people drift into their work only to "fire" them when they proved their unfitness costs the United States annually in both money and human suffering, it would be impossible to estimate. What it costs a manufacturing establishment in money has been fairly well established. Mr. M. W. Alexander gives us the result of an investigation covering twelve factories an indicated loss of more than $831,000 during the year entirely to reckless "hiring and firing." Other investigators estimate that it costs from $20 to $300 to fire one man and hire a second to take his place. They estimate that it costs $3,000 to hire and train a salesman, while President Loree of the Delaware and Hudson Railroad estimates that it costs a railroad $1,000,000 to break in a new manager. If a corporation can save the hiring of 1,000 workers each year it is evident a respectable amount will appear on the profit side of the ledger from this cause alone.

What profits must be saved by a company like that of Henry Disston and Sons of Philadelphia, who

*Professor in Charge of Engineering, Swarthmore College, Swarthmore, Pa.

boast of 19 men serving them continuously for 50 years or more; 90 who have served them between 40 and 50 years; 238 who have served between 30 and 40 years; 320 between 20 and 30 years; and 763 who have been with them more than 10 and less than 20 years. Families who have been on the pay roll for three and four generations. Think of a man being on the same pay roll for 55 years. This record certainly disproves the theory that workers in the United States are unstable. The problem of holding men, is not an impossible one, but it can not be treated as self-solving.

The successful directing of industry must include not only the proper selection of the worker, physically and mentally, but also means of building them up physically and developing them mentally; accidents, sickness and avoidable deaths must be minimized. It is not difficult to understand how physical and mental fitness become items of first magnitude. The human machine must be at his best in both respects to work at its most "useful pitch of energy." It is somewhat disconcerting to realize that of the 41,168 applicants desiring to join the United States Marine Corps in 1915 over 90 per cent were rejected as physically unfit. A man who is physically unfit for the navy is equally unfit for many of the trying conditions of industry. Absence from duty does not always indicate irresponsibility on the part of the worker. But as far as it concerns industry every time a worker is away from his machine on account of sickness, over head takes profits job. Even a plain, old fashioned cold contracted by a machinist has been estimated as costing an organization in the neighborhood of $100. Professor Irving Fisher estimates that there are always 3,000,000 persons in the United States on the sick list, about 750,000 of whom are actual workers. He estimates the aggregate annual loss due to this cause at $1,000,000,000, one-half of which he considers preventable.

Not only must the worker be right and be kept right physically, but the same is true mentally. Especially is it necessary to keep him in the right mental attitude. Mr. Frank Vanderlip, president of the National City Bank of New York, and a man known for his grasp of practical economics gives $50,000,000 as his estimate of the cost of the garment makers strike in the city of New York. The cost of the last anthracite coal strike he estimates at $120,000,000. It has been estimated that the loss to the United States for one year, due to strikes is upward of one billion dollars. Most of this could be saved,—theoretically it would all be saved if men were properly selected and handled.

At one phase of our industrial life money was considered the most important factor. But when we learned that there was an end to the largest bank account, we turned our attention to systems of organization. Organization in the final analysis consists of equipment, materials, methods, money and men, and the most important and least understood of these factors is men. The success of the organization depends upon bringing all these factors together in such an orderly manner that friction is everywhere reduced to a minimum. Most costly of all forms of friction, is human friction existing in an industrial organization. If an employe is physically or mentally unfitted for the work he is trying to do and therefore inefficient and poorly paid; if in addition nothing is done to create loyalty, to cultivate mutual friendliness and understanding between employe and employer; if further he is subjected to the humiliation of being "fired" several times during the year because he has not been fortunate enough to drift into the job in which he is not a misfit, one should not wonder that such a man develops a mental "hot box" and is ready for the agitator when he arrives.

We are a wealthy nation but how long can we continue such a profligate life? It has been made possible only because we are using up our great physical resources, but to these there is an end. Already our less optimistic prophets see our nation facing serious industrial problems after peace has been declared in Europe. We also have a problem of unemployment. The United States has an average of 14 per cent, of unemployment as against six per cent in Great Britain and two per cent in Germany. What would happen to an industrial organization having its machinery idle 14 per cent of the time, while its competitors had reduced their percentage of idleness to six or two per cent. This is a part of our national "over head" for which little is being done to correct. The great difficulty in a Republic is that no one assumes responsibilities for general national losses and inefficiency. Too much attention must not, however, be placed upon the thought that these items represents merely a national loss and are therefore matters for the statesman and politician. In the final analysis industry pays the bill, and the company whose destiny you may determine in the future, is probably today paying its tribute to these enormous losses. Nor is industry in the United States so prosperous that we can afford to overlook such losses. It is stated that there are about 250,000 business corporations in this country which have to do with trade and industry. This does not include banking, railroad and public utilities corporations. Of these over 100,000 report no income whatever, while 90,000 are making less than $5,000 a year. In the face of such facts, and the possibilities offered by scientific work in human engineering it is small wonder that thinking men with purely materialistic motives should be giving the "human element" such a prominent place in their thought and action. Aside altogether from any humanistic motives, man is as truly a raw material in industry for the engineer to study and experiment with as is iron or steel, cement or wood. "The most successful engineer of the future," said Gen. George W. Goethals, "will be the man who knows the human side of engineering, the workman who is master of human construction."

The problem must not be mistaken for one of system or machinery of organization. "It is not a

problem of business system or organization, it is more important for in the final analysis it is the human element in any organization that is principally responsible for its success or failure. You do not get far in the study of any system of management or business organization until you are brought face to face with the man problem. The problem may vary according to the type and number of men employed; it may vary with the geographical location of the plant; it may vary with the season and the financial condition of the country, but it is always present and the financial success of the enterprise involved is more often than not determined by the proper solution of this man problem." Neither is this problem beyond solution, it has simply been ignored by business men because its importance in relation to profits has not been understood until quite recently. The idealist may object to having the man problem attacked from the standpoint of profits. However, if it can be shown that whatever view we may take regarding the purpose of industry the man problem still takes the position of first importance, the cause of humanity will be wonderfully advanced. From the standpoint of the humanitarian there is no question but that industry exists for man. It is however better for the engineer to approach the problem from a less idealistic point of view and assume that industry exists for the purpose of making profits. Better still accept the business philosophy of Mr. Schwab who says, "A business must be profitable if it is to continue to exist," and then he adds, "but the glory of business is to make it so successful that you can do great things because they are great and because they ought to be done."

Thus in the small space at my command I have tried to point out a few of the human problems connected with industry that affect the engineer. The successful or unsuccessful grappling with these problems will certainly determine the degree of industrial peace, happiness and prosperity the nation is to enjoy; it may in fact ultimately determine the life or death of the Republic. The question is, does the engineer, who, more often than other men, becomes the industrial leader, propose to assume the responsibility of solving these problems, or is he satisfied to leave them in the hands of the professional reformer, the cheap politician and the agitator? I think there is no doubt as to the answer of my question and I expect to see the day when "Social Engineering" will be taught in all our technical schools as a part of the regular course. Whether a man directs two men or twenty thousand he is confronted with the man problem. Whether he follows the profession of engineering after graduation or turns to entirely different work, the knowledge gained in this subject would be of the highest value. If our Republic is to face the trying conditions after the war that some predict a knowledge of the underlying principles of "Social Engineering" may even be essential to intelligent citizenship.

BOOK REVIEW

Steam Turbines, by G. J. Meyers, Lieutenant Commander, U. S. Navy. Published by U. S. Naval Institute.

This book of size 8" x 12", 1⅛" thick was prepared to meet the needs of the midshipmen at the U. S. Naval Academy. It is divided into 17 chapters and an appendix devoted to the decision of the U. S. Circuit Court of Appeals in the case of the Curtis Turbine Co. vs. Cramp Co. The book is excellently illustrated with 161 large scale drawings and photographs. Inasmuch as the book is intended primarily foi marine engineers the description of the constiuction and operation of turbines is practically confined to the types found on shipboard. The author has however included a chapter on the mixed flow turbine anticipating its use for marine purposes.

The preliminary chapters on the properties of steam and its behavior in the nozzle are very brief and it must be said that some of the statements are misleading. This is especially true of the section on Steam Expansion in the nozzle. The bulk of the book however is devoted to a description of the turbine, the turbine auxiliaries, the gearing, and the general layout of the turbine units, for various vessels in the U. S. Navy.

Among the pleasingly unique featuies of this book should be mentioned the large sized type and the frequent use of the bold face type. The illustrations are not only exceptionally well labeled but are printed on an extension leaf, when necessary, extending their usefulness to several pages of text.

To all interested in the steam turbine, especially in its construction and operation, this book will be found to be most helpful. C. A. P.

ELECTIONS TO ETA KAPPA NU

Eta Kappa Nu, the honorary Electrical Engineering Society, has announced the election this spring of eight men of the class of 1918, and one of the class of 1917.

The names of the new members follow:

H. B. Reyes, D. H. Banks, L. H. Lathrup, C. P. Tobey, E. G. Henderson, T. V. Farnum, T. J. Ryan, R. G. Schaaf.

The one Senior elected was I. L. Moore.

THE CORNELL CLUB OF MICHIGAN OPEN NEW CLUB HOUSE

The Cornell Club of Michigan has opened a new spacious club house in Detroit. The object of this house is to provide a home for Cornell men working in Detroit as well as a stopping place for any other Cornell men who happen to be in Detroit for a short time only.

Any alumni or undergraduate, desiring information regarding this club house should communicate with J. R. Marvin Sec., 623 Dime Bank Bldg., Detroit, Mich.

ENGINEERING ABSTRACTS

Abstractors: **Prof. Barnard, Prof. Gray, Prof. McDermott, Prof. Diederichs, Prof. Albert, Prof. Wells, Prof. Ellenwood, Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Gage, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Lee, Asst. Prof. Pertsch, H. W. Brown, F. G. Tappan, F. L. Fairbanks, J. F. Wait.**

The Sibley Journal will mail the magazines containing the articles abstracted to its subscribers at cost price.

The Development of Carbon Brushes, by E. H. Martindale, *Electrical Review and Western Electrician,* March 24, 1917.

This is the first of a series of fourteen articles dealing with the solution of commutator and brush troubles. The first brushes were solid bars of copper, and these were later replaced by a laminated copper brush. The first patent on the use of the carbon brush was taken out in 1885, but the art of making brushes received very little study until about 15 years ago, when special research work was started by the carbon manufacturers, so that during the last ten years, and particularly during the last four, many new grades of carbon graphite and metal graphite brushes have been developed, and the designers of electrical machinery now allow the brush engineers to specify the best grade for each particular type of machine. The most recent development has been that of standardizing dimensions for brushes, and this work has now been completed by the Electrical Power Club with the backing of the Industrial Power Committee of the A. I. E. E. A. G.

Brush Composition and Characteristics, by E. H. Martindale, *Electrical Review and Western Electrician,* April 7, 1917.

The term carbon brush broadly includes those of carbon, natural graphite, artificial graphite, layers of carbon and wire gauze and sometimes even metal graphite or composition brushes.

Natural graphite is of a crystalline form. Amorphous carbon may be obtained as lamp black or in the form of coke. Artificial graphite is produced by heating coke in an electric furnace to change it to the crystalline state. For high current capacity, as for rotary converter slip rings, brushes composed of a mixture of graphite and copper are used, the mixture being pressed into blocks from which the finished brush is cut.

The characteristics of carbon brushes are the current density, strength, hardness, abrasiveness, (controlled by the percentage and composition of the impurities) coefficient of friction and toughness. Besides these we have specific resistance, contact drop, heat conductivity and current capacity.

The apparent density is the weight of the brush compared to that of an equal volume of water. For carbon and graphite brushes this varies from 1.18 to 1.75 and for metal graphite from 2.2 to 2.69. This characteristic of the brush is not of great importance except that other characteristics being the same a light brush will follow the movements of an eccentric commutator better than will a heavy brush.

The hardness of the brush is obtained by a scleroscope, and varies from 6 to 80. A hard brush will give a longer life than a soft one, and the relative hardness may be determined by scratching with a knife or with a set of lead pencils varying from 2-B to 8-H. The abrasiveness of a brush must be distinguished from its hardness. Pure carbon has no abrasive quality, but this may be obtained by the addition of impurities generally called ash in the form of silica quartz, iron oxide, mica and carborundum. Abrasive action is necessary to keep the mica flush with the commutator, and to keep the commutator polished.

The toughness of a brush determines its ability to withstand chattering, and the test generally made on brushes for railway service is to subject it to over one million vibrations of pressure varying from zero to five pounds per square inch.

The other characteristics will be treated in greater detail in the articles which are to follow. A. G.

The Mechanical Development of Aviation, by Neil MacCoull in *The Journal of the American Society of Mechanical Engineers*, for April, 1917.

This article begins by sketching briefly the early history of aeroplane development and it is interesting to note that the first power driven aeroplanes were the results of experiments made in 1889 by Sir Hiram Maxim and Samuel Pierpont Langley. These two experimenters were working independently of each other and both of them deserve great credit for their hard work which was carried on with so little encouragement from the rest of the world. The first machine of Maxim's had a very interesting steam plant, one which weighed only 11 pounds per horse power, including the boiler, engines, condenser, pumps, and water supply. The steam pressure used was 320 pounds and each of the two engines developed 180 horse power at 375 revolutions per minute. This machine was fastened to a straight level tract and demonstrated the lifting power of an aeroplane, but was not permitted to rise in the air due to the restraining effect of the tract.

Professor Langley was, at the same time experiment-

ing with mechanical driven planes and small models which were driven by rubber motors. After long tedious experience, he succeeded in making successful steam driven models and finally made one which had a successful flight of over 3000 feet. This was on May 6, 1896 and is the first time in history that a mechnical device ever flew through the air by its own power. After the success of this motor, it was only natural that a man carrying machine should be tried out. It is one of the unfortunate things, however, in connection with this work that due to a small detail in the starting mechanism, the man carrying aeroplane was not successfully launched and it never had a fair trial, but dived to an untimely end in the Potomac River. This caused so much ridicule in the hostile press, which believed that such experimenting as that of Langley's was foolish, that it undoubtedly hastened this man's death. Attention is called to the fact that a few years later Glenn Curtiss succeeded in making this same aeroplane fly successfully. The Wright Brothers made some very important and interesting experiments and succeeded a few years later in building successful aeroplanes.

The article then takes up the discussion of the enormous sums that are being spent in Europe for aviation today and mention is made of the fact that during the past two years Great Britain has spent $200,000,000 for air craft and the author makes a statement that "the world will be dumbfounded at the status of the aeroplane when the veil of the censor is drawn after the war."

He then discusses certain mechanical features of the following well known motors: Gnome, LaRhone, Mercedes, Hall Scott, Christofferson, Sunbeam, Sturtevant, Renault, Knox. He also discusses mechanical starters briefly and special guns as used for aeroplanes and the article closes with a brief statement of the use of mechanical stabilizers. F. O. E.

Successful Shrapnel Manufacture, by Chester L. Lucas. *Machinery* for March.

While it is hoped that the demand for shells will not be increased, no one can predict how soon thousands of American manufacturers may be called upon to make shell for their own government.

The problem of equipping for munitions manufacturing is in no way different from that of equipping for the manufacture of motor cars, cream separators, pencil sharpeners or any one of a hundred and one other products required in large quantities. In manufacturing any new product, there are certain preliminary stages that must be gone through if success is to be attained. The shell-making concerns who have succeeded have recognized this principle and have patiently gone through this period before attempting actual manufacture. The keynote to the whole situation is found in the old adage, "First be sure you're right—then go ahead."

Prominent among those who were successful in completing their shell contracts on time is the Westinghouse Air Brake Company of Wilmerding, Pa. Through the courtesy of A. L. Humphrey, vice-president and general manager, and O. W. Buenting, general factory manager, these details of procedure in organizing and equipping for this work are presented.

One reason for the success of the work in this plant was the limiting of the work undertaken to just one size of shell. Segregation of the shell work was an important factor in the success of the work. All shell work was kept in one building of the plant and three distinct departments were organized to take care of the cartridge cases, shrapnel shells, and time fuses. A tool-room was provided for each department. In this way the toolmakers became specialists in the particular line of tools for which they were responsible. In buying the machinery and other equipment for handling the shell work, two important points were constantly borne in mind. The first was to select only such machinery as would be useful in regular lines of manufacture after the shell business had passed. The second was to select as far as possible only such machinery as would do the work when run by operators of average intelligence. They were of the automatic or semi-automatic type, which when once set up would produce accurate work in the hands of the average run of unskilled labor such as applied for positions every day.

One of the most important steps taken was the checking of the specifications. Too much cannot be said of this preliminary work, as much trouble was thereby avoided, and when actual manufacturing commenced there were no annoying delays in finding out what had to be done to meet the requirements of the specifications. Absence of friction between the inspectors and the production force was a noticeable feature. There was no room for argument because in this shell plant "the inspector was always right." Over all the shell work was the chief inspector of the plant who had assistants in every department. The limits set by the shell plant inspectors were kept well within those called for by the specifications so that they would surely pass the more liberal gages of the final inspection. Owing to the extreme care used in all inspections, and especially to the careful heat-treatment inspection, almost no shells were rejected from the entire lot of 1,250,000. L. D. H.

The Submarine, by C. H. Bedell, *Journal of the American Society of Mechanical Engineers* for April, 1917.

This very interesting article has a special appeal to everyone at this time. The article is written so that the layman can really appreciate the discussion and it is therefore recommended to everyone as a fair statement of the submarine history and present day equipment. The author first brings out an interesting comparison of the modern submarine with the wonderful imaginary boat, *Nautilus*, of Jules Vernes' "Twenty Thousand Leagues Under the Sea." He points out some of the great differences between fiction and reality,

among the most important being, that the *Nautilus* was able to go around the world without stopping for its energy supply, whereas the modern submarine in reality cannot run submerged for more than one to two hundred miles. Secondly, the people on the *Nautilus* were supposed to have been able to see through the sea water for a distance of three quarters of a mile by means of powerful electric lamps, whereas the experience of those on the submarine as actually built shows that vision through a submerged periscope of a submarine is limited to a distance of some seventy-five feet, except in the very clearest of waters where this distance may be increased to two hundred feet. Thirdly, in our imaginary submarine, depths of 6,000 to 7,000 feet were readily obtained without any thought, apparently, as to the enormous pressure that must be sustained by the shell of the submarine. The plate glass windows of the illustration in Verne's book indicate that wonderful glass was used or else the author gave no thought to the subject of increased pressures as we go to great depths. Actually, we find that submarines are now built to go to a depth of about 200 feet. Another very interesting comparison with the submarine of fiction is that the imaginary engines were compelled to force the boat down against the great water pressure which, of course, is contrary to facts, for bodies heavier than sea water do not need to be forced down. The following paragraph is quoted in full from the article as it is believed to be of sufficient interest to justify such space.

"The question is frequently raised in our newspapers whether a ship sunk by collision or the like will sink to the bottom or go a certain distance and then remain poised. The question was raised at the time the *Titanic* was sunk. The solution of the question rests upon the compressibility of the material of the ship as compared with that of water. If the latter is greater than the former, and the depth is great enough, a point would be reached where the water would be as dense as the material of the ship, and there the ship would remain poised. For the purpose of calculation, let us take the extreme case of a solid steel ball dropped overboard in the open sea. Now, in general, we say that water is incompressible. This statement arose in comparing the compressibility of water with that of gas, such as steam. When an engineer allows water to get from his boiler into his engine cylinder, and the piston striking this water on the return stroke drives off the cylinder head, he says the water is incompressible. As compared to a gas it is incompressible, but as compared to steel it is compressible; indeed, it is more compressible than steel. Therefore, our steel ball as it descends into the sea and is compressed has water around it that is being compressed at a more rapid rate under the increase of pressure than the steel is. If the depth, and therefore the pressure, is great enough, a point will be reached where the water will be as dense as the steel and at that point the ball will remain suspended. A calculation based on the compressibility of steel and water shows that the required depth is about one hundred miles. As the sea is only some five or six miles deep, it is evident that our steel ball will go to the bottom. Now let us take the case of the ship that has been sunk. When she starts to go down she is heavier than the water around her. The ship, as a whole, is far more compressible than the steel of our ball, and will get relatively heavier as she descends, that is, will sink faster and faster until the bottom is reached. Return now to the submarine, where we have a hull that is perfectly tight. Since this hull is composed of circular frames on which is mounted the hull plating, its compressibility is far greater than our steel ball; indeed, it is far greater than water. In consequence, if a submarine is so trimmed down that she is even slightly heavier than water, she will sink to the bottom."

He then gives rather a full discussion of the history of the submarine, bringing out the fact that such a boat was first built about 1624. It was not, however, till much later time that the submarine really became of practical importance. The discussion of present day submarines is then taken up and a number of very interesting illustrations showing the building, launching and operation of these important war crafts are given. Concerning the equipment of submarines, the author brings out the fact that at the time of the first modern submarine no periscopes were used. Thus it was necesssary to have the boat come to the surface sufficiently to expose the conning tower, remain on the surface long enough to enable the observer to obtain his data and then dive. It is surprising to note how quickly this could be done, the statement being made that the boat can pass from a depth of 30 feet to the surface, line up on the target, have the torpedo fired and be again below, all in thirty seconds. Remarkable as this may seem, it is evident that the addition of the periscope is of the greatest importance. Then, again, the modern submarine is always equipped with wireless outside so that it may keep in touch with the shore and other vessels. The illustration which gives an inside view of the submarine shows very clearly how important space is and how very carefully every possible bit is utilized. The operation of submarines is discussed quite fully and perhaps one of the most interesting and instructive paragraphs is the following which is quoted in full.

"The subject of rescue of men from a sunken submarine seems to fascinate our inventors, as hardly a week passes but that some one comes forward with the same old method, that of a buoy of such a size that a man may get into it and then rise to the surface. It is not a question of getting a man to the surface—that is easily done, but of keeping him alive when he gets there. In this connection the statement should be made that there is only one cause that will prevent a submarine from coming to the surface, and that is the rupture of her hull. If the hull is ruptured, the pressure of the outside sea is brought upon the men. In our respiration air is taken into the lungs, the oxygen

taken up by the blood is used in the purifying of the blood, and a certain amount of nitrogen is retained in solution. This amount of nitrogen in solution in the blood is small at ordinary pressures, and in any case does no harm, for its quantity is a constant. If now a man is placed under heavy pressure, as would be the case if the hull of a submarine were ruptured say in 200 feet of water, this pressure of about 100 lb. per sq. in. would cause the blood to absorb many times its normal quantity of nitrogen. This absorption takes place very rapidly, it requiring but a few minutes for the blood to become saturated to the point called for by the new pressure. If now a man so placed should enter a can buoy and rise to the outside air, the pressure would be quickly relieved and the excess nitrogen of the blood would be given off all through the system, given off in small bubbles which would instantly stop all blood circulation and cause death. This action of the nitrogen is a familiar one to divers and all who are called upon to work under heavy air pressure. Thus it is not a question of the quick application of pressure, but the quick removal of that pressure. As an illustration, a few years ago a government diver went down some 280 feet off New London. He took two minutes in going down, spent five minutes on the bottom, and then started for the surface. He came up a little way and then stopped, exercised his arms and legs, thus encouraging activity of the blood in order to work the nitrogen off through his lungs. Then he would come up a little further and repeat the operation. The total time thus taken to reach the surface was one hour and thirty-five minutes, and even then as soon as he was taken out of his diving suit he was put into a recompression chamber so that the pressure might be still more slowly relieved. It will thus be seen how impossible it would be in the excitement of a wreck to go through any such procedure as outlined above." F. O. E.

EMPLOYMENT NOTES

*407. A rubber company has excellent opportunity for a recent graduate having high scholastic requirements, aggressiveness, ability to speak French and read German, and command of mathematics, in new branch serving the government.

408. Mr. C. L. Heisler, '89, Mechanical Engineer, Washington Steel & Ordnance Company, Washington, D. C., wants capable machine and structural draftsmen and designers.

410. Mr. A. S. Schultz, '09, Division offices, Bell Telephone Company, Harrisburg, Pa., wants recent graduate to follow up work of contractors. Should have some knowledge of building construction, electrical engineering, illumination, materials of construction, etc.

411. Mr. Charles E. Ward, president Charles Ward Engineering Works, Charleston, W. Va., wants recent graduates with fondness of steam and marine engineering. Start in shop on laying out and work of similar character. (Boilers, marine engines, light draft steamers.)

412. Mr. C. C. Hogue, Employment Clerk, General Electric Company, Erie, Pa., wants good tool design draftsmen.

413. The United States Patent office has urgent need for examiners ($1500–$2700). F. W. H. Clay, Assistant Commissioner.

414. Mr. H. C. Givens, Director Industrial and Applied Arts, State Manual Training School, Pittsburg, Kan., wants instructor in mechanical drawing (including some furniture design and architectural drawing). Start $1500, including summer session.

416. Mr. Alonzo Flack, care American Hard Rubber Company, 11 Mercer St., New York City, wants man for employment supervisor of a large concern. Must have push, tact and sympathy. Will look after records, hiring, welfare work, etc. Good future.

417. The Bureau of Construction and Repair, Navy Department, Washington, is very greatly in need of ship draftsmen and hopes that patriotism will induce men to take such positions even at the rather low salaries which Government regulations compels the Bureau to offer.

Graduates in naval architecture or others who have had some experience in ship drafting are eligible. It is of the greatest importance that men be obtained at once. Those interested should communicate with the Bureau of Construction and Repair.

419. Mr. Stafford Montgomery, '10, Riverside, Ill., wants draftsman on labor-saving appliances; man to make assemblies and shop drawings on basis of rough sketches furnished. Position in Chicago, starting at $25 per week.

*420. An Eastern technical college wants one instructor at $800 and another at about $1200. The men would be expected to assist in a variety of courses at different times and would get experience in many branches of engineering.

421. Mr. V. N. DeLamater, '00, assistant sales manager, Hyatt Roller Bearing Company, Detroit, wants man for sales engineer in automobile division. Man should have had at least five years' sales experience, not necessarily in automobile field. To travel, with headquarters probably in Detroit.

422. Mr. H. F. Wardwell, sales engineer, Detroit Steel Products Company, Detroit, wants recent graduates in M. E. and C. E. The former for shop work, and the latter for field work, with possibility of position as salesman.

423. Mr. H. L. Barnes, superintendent Whitman & Barnes Mfg. Co., Chicago, wants men with one to four years' experience for positions in their Chicago factory. "Excellent opportunity for the right young man."

425. Mr. Charles DeVed, '06, care DeVed-Kissick Co., Commonwealth Trust Building, Philadelphia, Pa., wants salesman who has had a couple of years' experience in selling, preferably in Philadelphia territory.

426. Mr. George F. Fenno, sales manager, Richardson-Phoenix Company, Milwaukee (lubrication engineers and manufacturers) wants recent graduates to develop for salesmanship.

427. The Schafer Ball Bearing Company, Hawthorne, N. Y. is reported to be seeking an engineer familiar with ball bearings.

*428. A concern publishing scientific and engineering text books has good opening for youg man of education, who has pleasing personality and who can make a good impression when consulting with prospective authors.

429. Mr. C. Claude Hogue, '14, employment clerk, General Electric Company, Erie, Pa., wants recent graduate for testing small gas engines for the government. Besides gaining valuable experience "they would also be doing their bit in the present national crisis."

430. Mr. C. S. Roberts, president Wahl Adding Machine Company, 232 E. Ohio St., Chicago, wants two or three technically educated young men.

*Send applications to this number Sibley Employment Bulletin for Bureau for forwarding.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI JULY, 1917 No. 10

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:
United States, Mexico and Canada, $2.00 a year
Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

CONTENTS FOR JULY, 1917

Military Aviators

Now that Cornell has been selected as one of the six Universities in the United States to give preliminary instruction to the enlisted men who are to become our army aviators, our interest in this branch of the service has been very much increased. It is extremely interesting to the engineer to study the wonderful development that has taken place in aeroplanes and engines during the war, and to learn something of the kind of men who are needed for army aviators. The latter subject will be the one discussed here.

Most civilians in America still think of a military aviator merely as an ordinary pilot engaged in military work. This probably means to them that he is an aviator of daredevil type, one reckless to the extreme. Now it is true that he must be a brave and skilled pilot, but he must be **much more** than that if he is to be of great value to his country. First he must be a man of high character. He must be honest and absolutely reliable, otherwise his reports of what he has seen while over the enemy will be of no value to his commander. If an aviator so chooses, he has, without doubt, the greatest opportunity of any man at the front to deceive his commander. He is sent up in the air for a long journey and no one but himself can now direct his movements, or report on what he has seen, or perhaps even where he has been. Yet upon that report depends the action of the commander of the modern army and thus is involved the very life of such an army. The aviators are really the trusted eyes of the armed millions.

The next requirement is that the army aviator shall be a **keen observer,** otherwise he will be unable to do the very thing expected of him. It is not a simple thing to control a high speed aeroplane in the midst of the enemy bullets so that you shall succeed in deceiving him as to your whereabouts for each succeeding second. Yet this must be done constantly and at the same time you must **observe** things of military value, and also send wireless messages to your own commander, or else perhaps locate on a map before you the exact position of some big gun which gives no evidence of its whereabouts except the quick flash seen only the instant after firing.

Furthermore, the military aviator must have determination and courage in abundance. He must also be able to recognize new conditions as soon as he meets them and then to act instantly. It has been found by the British Government that their best aviators have been college men, who were of the highest character, good students and skilled athletes.

To those of us of the Cornell Faculty who were recently sent to Canada to inspect the training school

(*Continued on page 11 ad.*)

THE RELATION BETWEEN PHYSICISTS AND ENGINEERS

*EDGAR BUCKINGHAM

The Editor has kindly given me an opportunity of making some remarks to the readers of THE SIBLEY JOURNAL OF ENGINEERING on the relations of Physics and Mechanical Engineering. The intimate connection of these two subjects is familiar to all, but the relation between mechanical engineers and physicists, which ought to be equally close, is not so often discussed nor its importance so clearly recognized. And yet such abstractions as Physics and Engineering get into contact only when the people who are occupied with them bring the contact about; so that these personal relations are worth some consideration. I may start by giving a picture of the present situation in this country as it appears to me.

The average physicist, especially one of the younger generation, is not interested in mechanical engineering —he neither knows nor cares anything about it. He knows that the principles of operation of the apparatus and machines with which the mechanical engineer is concerned may all be traced back to certain fundamental physical facts or laws, mainly Newton's laws of motion and the two laws of Thermodynamics. He regards Physics as being, in some undefined way, the custodian of the truth of these laws; the engineer as a mere borrower who sponges on Physics without giving anything in return; who degrades and commercializes the principles of pure science by doing with them something so vulgarly useful that the world at large is willing to pay well for it.

Naturally, with this supercilious attitude he pays little attention to mechanical engineering and does not appreciate the interest of the problems of technical physics. Accordingly, when the engineer who needs the solution of some such problem tries, as a last resort, to get help from the physicist, he is likely to be met by an indifference which he is often quite right in interpreting as a mask for ignorance. It is not surprising that he looks on the physicist as a useless duffer who, if he has any real knowledge, can't do any good with it, and is so shy of coming down to realities that it is a waste of time to try to pry anything out of him. Who shall say that the mechanical engineer is wrong in his conclusion? And if physicists are of no use to him, how can he be expected to have great respect for the subject with which they are exclusively occupied and about which, nevertheless, they cannot or will not give him any useful information?

Now suppose we turn to the mechanical engineer. Let anyone with a sound training in physics look at our mechanical engineering publications, and what does he find? Untold millions of useless figures—results of strictly physical measurements, made by unsuitable methods with antiquated instruments and recorded, in desperation, by some one who hasn't the training, even if he had the time, to analyze them so as to draw sound conclusions of general interest. And when the article in question is not burdened with masses of undigested figures, the chances are at least ten to one that it is written in shockingly bad style. For a well written technical paper clearly and logically arranged so as to be understood at once by the ordinary intelligent reader who will see it, is rare indeed in our literature of mechanical engineering. That there is an art of writing papers properly and that it is worth cultivating seems to be quite outside the scope of the engineering mind. Moreover, the lack of elementary physical knowledge often betrayed even by well known mechanical engineers, and the antediluvian values they use for familiar physical constants and pass on in text books and hand books to their students, would be laughable if they were not so pitiable. Is it, then, to be wondered at that the physicist gets an unfavorable view of the mechanical engineer and tries to keep up his courage by despising this ignoramus who somehow or other gets at least three times as much pay as himself, and with no upper limit?

Such is the state of affairs between the mechanical engineers and the physicists and these are their cordial relations as they appear to an impartial observer whose sole object in talking about the subject at all is to promote some sort of mutual understanding which will help toward coöperation.

Now let us enquire into the reasons for this situation: in so doing we may find some suggestions for improving a condition which is intolerably bad and equally disadvantageous to both sides. Some persons who will admit that the situation is much as I have described it, will perhaps not admit that it does any great harm or that it is worth bothering about. The extremists on each side will probably say that the other side is hopelessly stupid or ignorant or unpractical, and that to attempt to obliterate the sharp division between physics and mechanical engineering is striving for a worthless end. But if the extremist in question—and I think he is in a majority on both sides—happens to be a mechanical engineer, let him tell us what has been the result in Germany of the intimate coöperation which exists there between physics and engineering, as exemplified for instance in the work of the Munich Laboratory for Technical Physics. Does he think that this country is too stupid to derive any advantage

*Bureau of Standards, Washington, D. C.

from the sort of coöperation that has helped German Engineering to make such colossal strides in the last twenty years? Or if, on the other hand, our extremist is a physicist, is he so sure that technical physics is uninteresting or unscientific without looking at it? Does he think that biologists who make their work immediately useful to the public and often direct their researches with this in view, are degrading science? And if it is legitimate for the biologist to keep the practical applicability of his work in mind, as it certainly must be admitted that it is, is the physicist necessarily ennobling his position by postponing as far as may be the date when his investigations shall bear some practical fruit?

In reality, the mechanical engineer has been able to get on well enough in the past because things were so favorable that a good deal of waste and bungling could be tolerated; but the world has been waked up by Germany's example, and the blundering anti-scientific methods of the past are beginning to look out of date. England has been having a rough awakening and this country, even without the stress of war,* is beginning to recognize that coöperation between people who may have something to give each other is merely the part of ordinary common sense.

To the physicist it may be said that even the mechanical engineers, to say nothing of the electricals for example, are far more alive to the situation than are the physicists. There are numbers of problems in technical physics, such as the principles of heat transmission and various questions in aero- and hydrodynamics, which are crying for investigation because the engineers need the information. Engineers often attack these problems and sometimes get out useful general results. But it is seldom profitable to do work far out of ones own line, and a mechanical engineer making physical measurements is a fish out of water Engineers are getting to recognize this pretty clearly, and good work in technical physics done, as it must be to be done properly, by physicists is sure of its welcome by the engineers, who very naturally don't want to be obliged to spend their time on work for which they are not fitted by either taste or education. Why is it that so few men who are thoroughly competent in physics pay any attention to this class of research?

The answer to this question seems to me quite clear. In the first place, the physicist is repelled at the start by the monumental ignorance displayed by the mechanical engineer, not merely of the facts of physics but of all scientific methods of clear thinking and writing. If a successful engineer, a man of evident ability, a graduate perhaps of a famous technical school, hasn't an inkling of scientific ideas, what chance is there of ever understanding him or his problems,—the physicist sees no opening, and unless he has a very strong natural bent toward engineering, he turns away from the problems of technical physics into a path of less resistance.

But suppose that the physicist does take a look at some of these problems; is he likely to take up any of them? No, and the reason is not that they are uninteresting but that they are too hard. Many of them require an equipment beyond the reach of the average college instructor, which is what most physicists are; but the problems are difficult in another way. In our physical laboratories we work almost exclusively on problems which can be ideally simplified, and we prefer this because general relations come out so much more definitely. There are still plenty of such problems to work on without going on to the often almost hopelessly complex conditions inseparable from the physics of every day life. Hence to take up these technical investigations needs a strong incentive. This incentive is usually lacking, and at present the tendency is quite in the opposite direction. There are fashions in physics as well as in medicine and other professions, and just now the fashionable idea is that the aim of physics is to investigate the ultimate nature of matter. The fashion has been set by a few very clever men who have had wonderful success and have dazzled the imagination of the whole body of physicists by their discoveries and by the boldness of their flights of fancy. As a result, scores of young physicists who have plenty of ability to grind out useful experimental results along old fashioned lines, are wasting their time trying to be brilliant, which is beyond them, or hoping for some easy success, i.e. cheap notoriety, from a lucky guess—a very slim chance.

Now while all this more or less metaphysical searching into the constitution of the universe is of course a very interesting and important branch of physics, to put it forward as the one great object worth striving for and to teach it and talk about it as if mechanics and thermodynamics were as out-of-date as alchemy, is mere fantastic nonsense. And it is worse than that, for our students of pure physics instead of getting, in their college courses, any proper appreciation of the realities of the world as it is accessible to our observation, are constantly taught to think of everything in terms of electrons, quanta, relativity, and what not. Instead of being taught to observe bodies—the only things which are in fact observable—they are fed first with molecules, the smallest things the teacher thinks the young physicist can believe in without seeing them. After molecules have got so familiar as to appear about the size of tennis balls, the student's eyes are considered to be sharp enough for electrons to be quite visible to him. And so it goes on, with the result that the mechanics and thermodynamics of bodies, a thorough grounding in which is absolutely indispensible to any sound training in Physics, get scant attention, especially in the sense that their fundamental importance is overlooked. With this sort of schooling, it is no wonder that the young physicist does not have much interest in mechanical engineering—he doesn't know the right sort of physics to enable him to take an intelligent interest in its physical problems.

*This was written several months ago.

As for the engineer, I suppose it is admitted that it would be well if he knew something about physics; for otherwise the pretence of teaching it to him would hardly be continued. But it is only a pretence in most cases, to judge by the results. It is not to be expected that the engineering graduate shall be an accomplished physicist, nor is it at all necessary that he should be. But what he ought to have got from his teachers, primarily in his physics courses, is a power of looking at things in a scientific way. While he must later, of course, be an opportunist in his profession, he ought also to have a feeling for the principles of things and an interest in the general aspects of the subject of which his special problems are particular examples. This breadth of view is what the engineering schools fail to give, and they fail lamentably. To judge from the engineering text books, the first thing to be done with an embryo engineering student is to make him accept it as an axiom that the only safe place for your brains, if you have any, is in the safe deposit vault where there wont be any danger of their being used unnecessarily. Until the student accepts this axiom it must be difficult to make him swallow the medicinal doses of knowledge reduced to empirical formulas which are given him instead of the wholesome food of general underlying principles, along with enough mathematical grind to make sure that he can really use, with some facility, the small amount of algebra and calculus he will need if he is to be master of his profession.

The reason why learning empirical formulas is so much more common than assimilating principles is quite obvious upon looking over the general run of engineering text books. The people who write the books frequently do not have any grasp on the principles, and naturally they can't teach what they don't know themselves. Such matters as the theory of the Pitot tube or of the steam turbine nozzle, for example, will be treated in the usual elementary way—if indeed the student is not made to swallow the formulas whole—and then a lot of empirically determined co-efficients will be introduced to take care of the divergence between theory and practice. The assumptions and limitations of the theory will not be clearly discussed nor will the obvious physical reasons why the theory can not be expected to represent the facts at all exactly, be set forth, nor the empirical constants interpreted. The student simply sees that here is a theory which so far as he can judge ought to be right, but in fact isn't within gun shot of right until it has some further experimental information put into it. The result is quite naturally and, under the circumstances, quite properly, that after a few unexplained examples of this sort the student makes up his mind that "theory" is useless. And so it seems to have come about that a "theory," in the language of mechanical engineers, means some statement, usually in mathematical form, which pretends to be true but isn't—a mere sham. The sort of theory that has led to the ammonia compression refrigerating machine or the Diesel engine or the gyrocompass or the Föttinger transformer is hardly regarded as theory because it has led to a useful result.

These conclusions which I draw from the examination of some of our mechanical engineering text books and other literature, are to me a pretty plain indication of the sort of instruction given in our engineering schools. There are good books and well written articles, and there are doubtless many competent teachers; but the general average is poor.

Now what might be done about it all, if we were not too lazy? The general answer is: try to stop being superficial; lay more stress on quality and less on quantity; give the student less teaching and make him work more; save some of the time he wastes in running from one class to another and of the energy he wastes jerking his mind from one subject to another; and let him burn more midnight oil. Our whole system of schooling—it can hardly be called education—from the kindergarten to the university is full of sham, bluff, and superficiality; quantity has altogether got the upper hand of quality; thoroughness is out of the question because "we don't have time for that," as is the constant cry of the teachers. One of the silliest of these superficial notions, and one of the commonest, is that a high passing mark means a high standard. The sort of examination or other test of the student's work which jams three quarters of the average class into the space between 70 per cent and 100 per cent is an absurdity. It is a rare class in which the best man isn't at least three times as good as the man who is just good enough to pass, and tests which conceal this are misleading and unfair. If every college and technical school in the country would put its pass mark at 30 per cent or 40 per cent and then set examinations on which only a Maxwell or a Kelvin could make over 90, students would begin to notice that brains and hard work counted. As long as the man who just scrapes through is rated, on paper, as seven or eight-tenths as good as the real star, students are not going to care much about doing their work really well. A great many people decry what they call "working for marks," but I never knew anyone to do so who had ever had any high marks himself. Students who have brains and work hard always get high marks, and ninety-nine times out of a hundred the students who just scrape through couldn't do much better no matter how hard they tried. My experience as a student and as a teacher is that competition for the honors and privileges of high rank is just as well worth encouraging among students as among naval officers or any other class of human beings.

To come back to suggestions for teaching,—there isn't much to be said to the physicists. After a while they will find out that it pays to be practical and that it doesn't at all interfere with ones being scientific. Then they will begin to understand why there are so few big endowments for physics and why physicists get such low pay. Specific suggestions, as for instance to make sure of the elements even if it takes the whole

four years of a college course, would probably get lost in the mists of relativity before they reached the ears of our physics teachers.

And specific suggestions to engineering teachers will hardly be expected from one who has never had any engineering training and who has only a little book knowledge of a few parts of the subject. But there is no possible doubt that our engineering schools make far too many demands on the student's **time** in comparison with those they make on his **brains**. For example, shop work is given in an exaggerated amount because it is "practical"; and mathematics and physics suffer because they are "theoretical." The student will never again have leisure to study these more difficult subjects, while his whole life is to be spent in practical work. Any one who has it in him to be practical, will learn the practical side of things fast enough when he gets his jumper and overalls on and has to work for a living; but after he has had them on for ten hours a day he will never have brains enough left at night to study the things he might have learned in college but now can never have at his command. I have tried it and I know. Again, it is the short-sighted superficial view that prevails: the student must be prepared to earn as much as possible the first year after he graduates, so of course no time at all can be allowed for learning in practical life—he must know all about practice when he graduates. If this were really possible things wouldn't be so bad, but everyone knows that it is not possible. No matter how good the "practical" part of the college course may be, it is still a long way from the real thing, and the gain is not enough to offset the loss of something which is irretrievable and which is worth while, in spite of its not counting for much in the first two or three years' earnings. The gap between engineering schools and trade schools is nowhere near wide enough.

If any of the foregoing remarks are sufficiently irritating to stir up discussion, my time will have been well spent. Things are certainly going to improve and any sort of discussion is likely to lead forward and not backward.

DISCUSSIONS

I think that Dr. Buckingham somewhat exaggerates the lack of mutual interest and appreciation on the part of engineers and physicists. The picture that he draws corresponds better with the conditions existing ten or twenty years ago than with conditions at the present time. Nevertheless, there is a great deal of truth in his statement of the case; and, although the situation has improved, it ought to improve a great deal more.

It seems to me that some means must be found by which the important advances of physics may be made more intelligible to the engineer and by which the work of the engineer may be made more interesting to the physicist. Although the physicist realizes that engineering is applied physics, he does not know enough of practical engineering to enable him to appreciate the employment in engineering devices of the physical laws and principles in which he is interested. If he had more familiarity with engineering he would find he would find the whole matter extremely fascinating and would be led to work more along engineering lines. On the other hand the engineer who is ready and anxious to take up new discoveries in pure physics and to apply them is often unable to do so because his knowledge of physics is not sufficient to enable him to keep in touch with the development of the pure science.

In a college community the situation would be helped by two series of lectures, one intended to give engineers a general notion of the progress of physics and the other to give the physicist some idea of the applications of his science in engineering. Better still would be books written with the same purpose. Unfortunately it is not easy to find men who are competent to write such books or deliver such lectures. It requires knowledge and appreciation of **both** physics and engineering, and men who possess such knowledge in adequate degree are rare. The demand for such men is undoubtedly far greater at present than the supply. But just as the importance of problems in the borderland between physics and chemistry led to the science of physical chemistry, so in the present case there must sooner or later be developed a science or profession, of engineering physics. I think there are many evidences at the present time of a tendency in this direction.

ERNEST F. MERRITT.

I have little comment to make on Dr. Buckingham's article. There may be some general truths in the argument, but I think that many of the statements are seriously over-drawn to make the case. The mechanical engineering profession as an average does not I think, need to plead guilty to monumental ignorance of physical laws, and the implication that a **successful** engineer may have no inkling of scientific ideas, carries its own refutation. The attack on engineering education contains little new. I believe that engineering teachers, in general, can deny, with a clear conscience, the charge that they do not attempt to get the students to use their own brains. Much might also be said from the mechanical engineers' standpoint concerning the relation between theory and practice. It is quite often forgotten by the laboratory expert, be he experimental engineer or physicist, that the engineer in the field must have usable tools and if, in order to reach that end, he must discard some of the close theories developed in the laboratory in connection with a given apparatus or instrument, he is perfectly justified in doing so, provided he can get results of sufficient accuracy. To what extent the introduction of imperial constants may go, is of course a matter to be pointed out in the class-room, but I never knew of a case where such an exposition engendered contempt for theory in the mind of the students.

The subject matter of the paper as a whole, i.e., the relation between physicist and the engineer, is one which may lead to a lot of discussion, which, it seems

to me, will not have any great practical result. The fields of endeavor of the two experts are naturally separated when we get away from the fundamentals of the science of physics. There is and always will be a connection between their fields, but to me the relation appears very much like that between office lawyer and trial lawyer. The former, works in his law library, like the physicist in his laboratory, and the results of his labor are put to practical use by the trial lawyer. In some such way the engineer should use the facts that the physicist furnishes him.

On the other hand, the physicist, like the office lawyer, should be equally ready to take up the consideration of problems (cases) that his partner brings to him. That, I consider is Dr. Buckingham's argument in a nut-shell, and if the parties concerned do not work in harmony, they are equally to blame.

HERMAN DIEDRICHS.

I have read Mr. Buckingham's article with a great deal of interest and with considerable profit. I think perhaps he is a little extreme in his discussion of the relations between physics and mechanical engineering, but undoubtedly there is a great deal of truth in what he says. The physicist has not been interested in the problems of the mechanical engineer to the extent that he should be, and undoubtedly the mechanical engineer is not nearly as well grounded in physics and other fundamental sciences as he should be. Much of the research work done by engineers has been faulty because of this fact, and unquestionably a great deal of engineering literature is superficial for the same reason.

Mr. Buckingham is right also regarding the difficulties of engineering problems. They are not simple problems and can not always be settled in the concise way in which problems in physics are decided. As Mr. Buckingham also points out, we know so little in many fields of knowledge about basic facts and laws that the engineer is compelled to fall back on experience. This will probably always be so. It is not likely that we shall be able to reduce such work, for instance, as design to an absolute mathematical and physical basis. If, however, as Mr. Buckingham has pointed out physicists could be interested in these fields undoubtedly the criticisms that he has made of engineering text books would begin to disappear.

He expresses one opinion which I think is often overlooked. He says the engineer should acquire from his teachers in physics "a power to look at things in a scientific way." This is true not only of physics, but of all the fundamental sciences and true also of much of the engineering content of technical education as well. We are too prone to lay stress on quantity instead of quality, and to forget that after all the most important thing is to send out men who can think clearly and concisely.

This ideal, even while understood, is not an easy one to attain, particularly as the demands of the engineering field are so complex and since this demand insists that the embryo engineer should, on leaving college, know something about the practical side of his calling. I cannot agree with Mr. Buckingham that it is not necessary to give a man practical training in connection with his college work. The successful engineer must always be a practical man and it should be a part of his fundamental training to be able to see the practical limitations of every problem that is laid before him.

DEXTER S. KIMBALL.

Dr. Buckingham has presented a timely discussion, from certainly an impartial viewpoint, of a subject of very great importance in these days of organization and efficiency. The "get together" spirit is growing. Its development is frequently hindered only by misunderstandings. There is no better way to approach, with a charitable attitude the other fellow's shortcomings, as we **think** we see them and thereby clear up these misunderstandings than by introspection of our own faults after having them pointed out by an impartial observer.

If the physicist and the engineer are as Dr. Buckingham points out, not coöperating with each other as fully as the close connection between physics and engineering warrants, we may well ask the question "why"? A complete answer to this question would probably require a volume of space and an analysis of present economic and educational conditions in the light of the history of the development of physics and engineering. But brief mention may be made of one or two points which have a bearing on the question.

First, as has been the case with all science, it has been found, as a result of experience, that the great discoveries in physics which have been of so much practical value, have been generally made by those who had little or no thought of the "applications" of the work they were doing. And hence we hear so much about "science for science's sake"—with the assumption, usually well founded, that the applications will take care of themselves. And they usually do, though with possibly not the highest degree of efficiency. It would, however, be very unfortunate if the physicists of the country, even as a class, should in recognition of this apparent lack of coöperation, devote their energies exclusively, or even to a large extent, to the solution of so-called practical problems. Greater progress would probably follow for a few years, but the ultimate result would be to cut off the engineer's supply of raw material. What we need is not a general change of attitude on the part of **all** physicists, but a larger number of men, whether physicists or engineers, to devote their entire time to this middle ground between engineering and physics. These men should have a thorough training in physics, and should know enough of engineering to grasp the engineer's viewpoint and apply it to this special field. The present rapid development of industrial physics—the demand for industrial physicists far exceeds the supply—is a movement in this direction.

But the physicist has other obligations. Physics is essentially a basic science. Its laws, its methods, and its new discoveries are carried over into other sciences, as well as into engineering. The astronomer studies the stars by means of spectra, the laws of which have been established in the **physical** laboratory. The physiologist, utilizing the phenomena of electromagnetic induction for muscle stimulation, makes an indicator card of the action of a frog's hind leg and by a planimeter studies the effect of alcohol on muscle tissue; or by means of the exceedingly sensitive and delicate string galvanometer, he photographs on a moving plate the variation in electromotive force between two unsymmetrically situated points on the body during a heart beat, and, by the form of the curve resulting, studies the pathological condition of that muscle. The phenomena of X-Rays have revolutionized a large part of medical practice. And the usefulness of X-rays in medicine was increased manyfold by the discovery and utilization of the emissions of electrons from hot bodies—which made the Coolidge tube possible. The geologist uses the phenomena of polarized light to analyze thin sections of his rock specimens. We need **some** engineering physicists, **some** astronomical physicists, **some** geological physicists, but we shall **always** need physicists.

F. K. RICHTMYER.

SOME MODERN PROBLEMS OF TELEPHONE ENGINEERS

STANLEY R. EDWARDS*

Like every business, the telephone has new and interesting problems to be solved continually. What was considered good practice several years ago, is no longer so regarded. Methods change just as do the styles of women's clothes, but the reasons are different.

It was only a few years ago that the standard practice for the telephone connection from the building to the pole or terminal box required the use of twisted-pair, weatherproof copper wire of No. 14 B. & S. gauge. So great was the demand for this kind of wire that for a number of years it was difficult for telephone companies to secure a sufficient supply for their needs—and the price was correspondingly high. Then the engineer of one of the large companies—he was also general manager—experimented with copper-clad wire.

The result of his investigations proved so satisfactory—a saving of $25 per mile being effected—that today the use of No. 17 B. & S. twisted-pair copper-clad wire for the subscriber's drop, or connection between the building and the line wire, is standard practice. The use of the copper-clad wire is said to have effected an annual saving to the Bell Telephone Companies alone, of considerably over a million dollars.

The adaptation of the deForest audion or repeater, to wire telephone lines resulted in the transmission of the voice across the continent. But before this was accomplished, the Pupin loading coil had to be developed and applied to long distance telephony. How long this development took, may be judged from the fact that Dr. Pupin's announcement of the lumped inductance theory was made in 1899, and the transcontinental line was opened early in 1915. The successful combination of the Pupin coil and the audion repeater has brought about a wonderful extension of telephonic transmission.

A problem relating to telephone lines, which has received a great amount of attention in the last three or four years and which is now receiving great attention is that of inductive interference from power transmission lines. In California, extensive study has been made relative to the effect of high tension currents upon telephone and telegraph lines. These have been embodied in reports presented to the California Railroad Commission and as a result the commission has issued an order looking to the minimization of disturbances on telephone and telegraph lines from power transmission lines.

In the course of the investigations many technical facts were discovered and others which were already known, were corroborated.

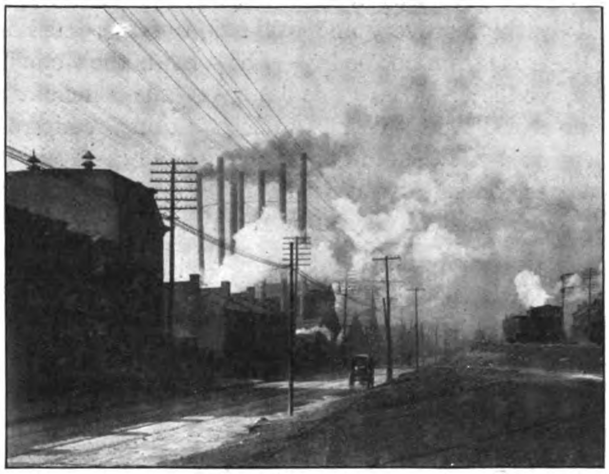
In the Middle West, especially in the states just west of the Mississippi where there are many telephones operating on the grounded system, the entry of power transmission lines is a most serious matter. The power companies and the telephone companies are, however, co-operating in most cases, and serious difficulty is thus being avoided.

The disturbances on telephone circuits due to power and lighting currents, if the apparatus of both companies is of the standard types and the lines are properly constructed, are due to three causes. These are: Direct leakage from one line to another; the grounding of the telephone or electric light lines; and an unbalanced condition of the lines.

The first-mentioned cause—direct leakage—may be due to both lines passing through the branches of the same trees, to the breaking down of insulators especially on joint construction, or the insulators being coated with soot, as at railroads or near factories where there is a great deal of smoke. The difficulty due to the latter is not frequently encountered.

*Managing Editor *Telephony*.

Tree leaks are not uncommon and in many cases they are most annoying. It may be the lines are built and properly transposed to eliminate the noise and are nearly or commercially quiet, but the tree branches grow around them and so the noise slowly increases.



PITTSBURGH'S SOOT MAKES HIGH INSULATION OF TELEPHONE LINES DIFFICULT TO MAINTAIN

The result is that employes or inspectors who check the line conditions daily, do not notice the growth of the branches and loss of business, especially long distance, is the first indication that a serious condition exists.

The grounding of the telephone or electric light lines can usually be found by test, either by the telephone company or the power company or by both. On the ordinary primary lighting circuit within town or city limits, there is a considerable possibility of the power circuits becoming grounded and no attention being paid to it by the central station operator. On the high voltage transmission lines of 10,000 volts or over, there is very little liability of grounds, except leakage at insulators, for heavy grounds very quickly show up at the generating plant.

An unbalanced condition of the line may be due to: The electric light current being split up, as in a series street lighting circuit; the telephone circuit being out of balance, as in a common return system; or when one of the wires of a metallic circuit is of a larger size and consequently of lower resistance or some foreign wire is connected to one side of a metallic line. An unbalanced condition of the telephone circuit may also be due to improper transposition.

The series street lighting circuit under normal conditions, is one of the hardest conditions telephone companies have to contend with, and it is advisable to keep as far away as possible from that type of feed wire. An illustration of this kind of trouble was experienced in a place where a phantom telephone circuit was noisy at night when the street lamps were lighted. Investigation showed that there were two underlying reasons for the trouble. The arc lighting circuit was only three feet away from the telephone circuit and at the same height from the ground. There was also a ground on the lighting circuit somewhere on the loop which paralleled the telephone circuit.

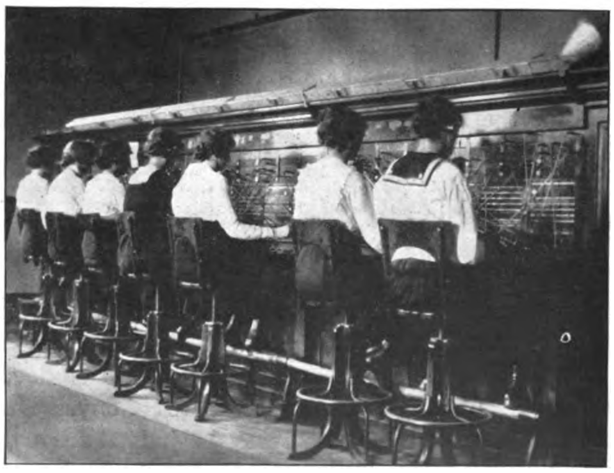
The ground on the lighting circuit was cleared up and part of the trouble eliminated. The arc wire was then brought directly below the telephone circuit and the proper transpositions cut in the telephone circuit. There was then no noise on the telephone line.

In practically all cases, transpositions will eliminate all the noise, if properly placed and if the circuits are otherwise clear. It is quite essential to cut in the transpositions so that each wire of the telephone line will be the same parallel distance from the nearest wire of the lighting circuit and have the same number of running feet.

Sometimes the cause of inductive trouble is not at the point where the telephone and power lines parallel. The telephone circuit may be properly transposed along the parallel to take care of the induction but a grounded telephone circuit on the same poles with a metallic telephone line a number of miles away, may be the cause of the noise. The effect produced is the same as if condensers were connected to one wire of the metallic circuit and grounded. For this reason toll line companies are very loath to allow any grounded circuits on their heavy trunk leads.

In the case of grounded telephone circuits, the only effective remedy where power transmission circuits are on the same side of the highway with them, is to make the grounded telephone circuit metallic and to properly transpose the wires. With the grounded telephone circuit on the opposite side of the highway from the power transmission line, satisfactory operation of the telephone line may be had, especially if the lines of the power company are free from leakage. If, however, there is noise on the telephone line, the only effective remedy is to make it metallic. In such cases the transmission companies are usually willing to bear a considerable part of the expense.

In the early days of electric lighting, service was furnished on the flat rate basis. At the present time, however, it is practically all on a metered or measured service basis. Telephone service is approaching the same kind of an evolution. In the large cities, measured service for local telephone calls has become



LOCAL OPERATING ROOM

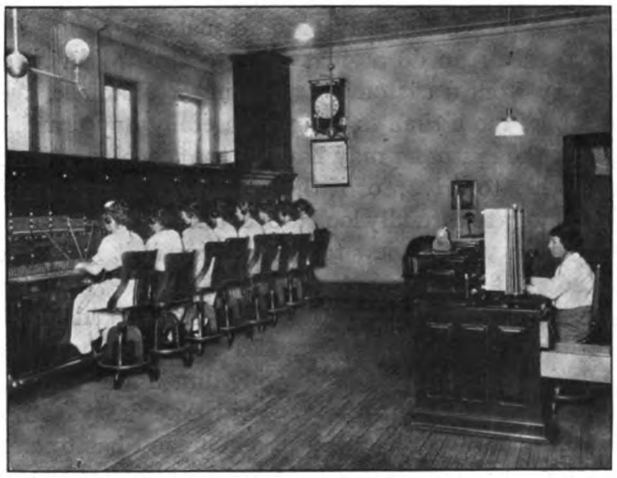
a recognized standard. Whether or not this standard will prevail and be extended, the future can only determine.

Long distance calls are charged for on a time basis in which a time unit is involved. A number of patents have been issued covering methods of measuring local service on a time basis but none of them have come into commercial use. Undoubtedly for some years to come flat rates will be used in smaller communities without serious impairment, but in the larger cities the message rates or rates based upon a time standard, will come into general use.

The question as to where the meter for recording or measuring the service should be located is one which has aroused considerable debate. In the furnishing of water, gas or electricity, the supply of the patron is taken from common mains and the measuring meter must necessarily be placed on the patron's premises.

Telephone service, however, is not furnished from common mains. It is furnished to individual subscribers over separate and distinct pairs of wires. The means for measuring the surface can therefore be very advantageously concentrated at the central office where they will be under constant supervision of skilled operating and maintenance forces. Where several people are using the same telephone line, it is very difficult to get an accurate record of the telephone conversations, when meters are located at the subscriber's station. It is so easy to forget to make a registration of the calls and then many telephones are open to the surreptitious use.

Another argument in favor of placing the telephone message meters in the central office is that the meter may be associated with the third or signaling wire which is installed only in the telephone office and is not connected with the subscriber's talking circuit.



VIEW IN THE OPERATING ROOM SHOWING A TYPICAL MANUAL SWITCHBOARD OF THE SMALLER CLASS OF COMMUNITIES

The reading of the meter may be taken very easily. In fact, in some of the offices the camera is used to secure a photograph of the reading. A number of tests have shown that seldom or never do troubles occur which occasion over-registration of calls, while there are quite a few kinds of trouble which cause under-registration.

The accuracy of the meters used in New York City has been demonstrated to be very high. The percentage of error in message registers is considerably less

ONE TYPE OF SEMI-AUTOMATIC SWITCHBOARD EQUIPMENT WHICH NOW HANDLES MORE CALLS THAN THE OLD MANUAL SWITCHBOARD IN THE BACKGROUND

than one per cent, according to evidence presented to the New York Public Service Commission.

The tendency in all telephone equipment is toward concentration in the central exchanges. Where formerly talking current was obtained from the battery installed in the subscriber's telephone, it is now taken from a large storage battery at the central office which supplies current to all subscribers in the exchange. This is also true of the magneto generators which were used for ringing the central operator and calling other subscribers. The ringing of subscribers' bells is now done by means of a ringing generator at the central office. The work of both the subscriber and the operator in making a call has thus been reduced.

On manual telephone switchboards, many improvements have been made in the last few years, all tending to reduce the number of motions necessary for an operator to make in putting up a connection.

Commercial application is now being made of inventions recently patented which do away with the ringing and listening keys of the operator. Where formerly the operator had to operate a key in order to get in communication with a calling subscriber, this is automatically done when the connecting cord is associated with the calling subscriber's line. Then when connection is made with the called subscriber's line, the operator is automatically disconnected with the ringing current connected to the line. Thus the listening and ringing keys are dispensed with. Provision, of course, is made so that in case the operator is desired again by the subscriber, she can be signaled.

Another application to manual switchboards is the provision of call distributers for apportioning or distributing the calls among the operators, thus preventing a call from being held up on account of an operator being busy with other calls. The trend in manual switchboard development is, as has been intimated, toward lightening the work of the operators

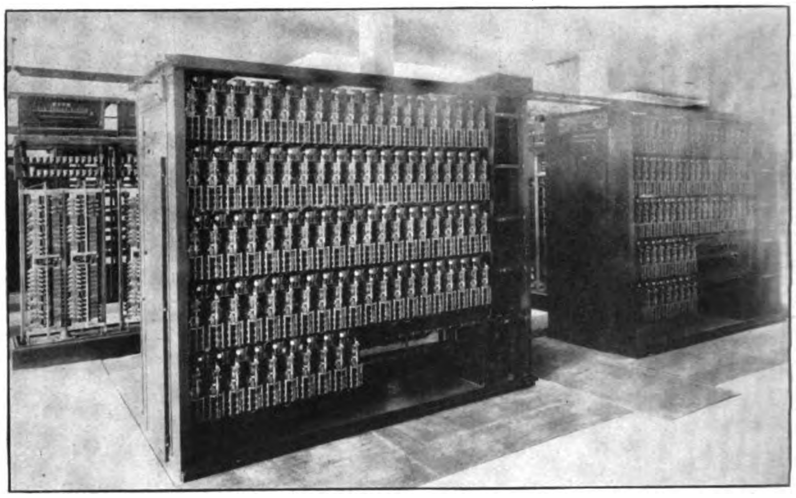
so that each may handle a greater number of calls.

In the larger cities the operating telephone companies are experiencing great difficulty in obtaining operators and this is one of the great factors in favor of automatic telephone systems. It is authoritatively stated that a company in one of our large cities spent over $6,000 in January alone for advertising to keep the operating force up to normal. And that amount does not include the expense of training for several weeks before the operators are assigned to work at switchboards.

The Strowger automatic system is that which is in use in over 100 cities in the United States. The systems which have adopted the automatic telephones are those known as Independent telephone companies as contrasted with the Bell Companies.

Although engineers of the Bell companies have been working upon the automatic telephone problem for years, no satisfactory system has as yet been evolved. Experimental installations of both semi-automatic and full automatic apparatus have been made by the Bell Company, but no announcement has been made of equipment which will stand commercial use.

There are conditions quite clearly defined under which the manual telephone switchboards are the best for the purpose. Again a combination of manual and automatic, known as the semi-automatic would seem to answer the requirements. In other cases a full automatic system would be the one which would give the highest efficiency and best service.



The Switchboard of an Automatic Exchange is a Great Contrast to that in a Manual Exchange

These are the questions relative to exchange equipment which will have to be answered by the telephone engineers in the ensuing years of the immediate future, for Americans demand that their telephone service be the very best it is possible to provide.

ENGINEERING ABSTRACT

Manufacturing Conditions in the Electrical Industry, by D. B. Rushmore and E. W. Pilgrim, Power and Mining Engineering Department, General Electric Company, *G. E. Review*, May.

This article is a plea for the employment of standard lines of electrical apparatus wherever conditions will at all permit of its application. The great demand at this time for products of all kinds has forced manufacturers to work for maximum production, and this means concentration of effort on developed apparatus and the elimination of all special equipment. The observance by customers of this desideratum in making out specifications would work no special hardship to them, as the lines of developed apparatus of all varieties are very extensive and sufficiently broad to fulfill all ordinary requirements.

As an example of the wide range of choice among standard developed apparatus the 25 h. p. induction motor is cited. These are listed at five different speeds, four voltages, three frequences, three forms, two phases, or a total of 360 different motors. There are six sizes between 15 and 50 h. p. inclusive making 2,160 standard machines.

Any one of these motors can be furnished with pulley and base for belt drive, with short shaft for coupling or gearings, with windings treated to resist moisture for operation in mines and other damp places, with back geared attachments, or with vertical parts; which means that the company stands ready to supply 10,800 different induction motors from 15 to 50 horse power of only one type, and there are listed 15 different types.

A special switch will take about five times as much time for production as a standard one and consequently must cost more. Not only will it cost more but it will increase the cost of the standard makes.

Salesmen can do a great deal if, when receiving an inquiry from a customer or visiting a customer, they will take more time to go over carefully any drawings which the customer may have of the machinery which he wishes to drive; or if the machinery is installed in his factory to carefully look it over and make a thorough inspection with a view to determining if it is possible to adopt a standard machine. When new developments are being contemplated, salesmen should at once see that the interested parties are furnished with bulletins and white prints showing dimensions and ratings, and other literature, so they will be perfectly familiar with the standard lines which a company has to offer.

No doubt a very great saving can be brought about by a more thorough co-operation with customers before specifications are written or inquiries for propositions sent to the factory. At the present time, on account of the shortage of both labor and material this will be of the utmost importance, and the only way by which shipments can be bettered will be to keep production along standard lines. F. G. T.

UNIVERSITY NOTES AND PERSONALS

Frank Short, '13, has left the Western Electric Company at Chicago to attend the military training camp at Fort Sheridan, Ill.

Enrique S. Outes, '13, is an electrical engineer in the employment of the Argentine National Republic.

Celos Lopey, '15, is general manager of his father's telephone company in Buenos Aires.

P. S. Goan, '13, of Billings, Montana has bought out the entire interest in Sime & Goan, wholesalers and retailers of Chevrolets, Paiges, Federal trucks and Vim trucks. The new firm will be the Goan Motor Company.

B. S. Loney, Jr., '14, is in Company C, Reserve Officers Training Camp, Fort Sheridan, Ill.

Norman S. Stone, '14, is at the Officers' Reserve Training Camp at Fort Sheridan, Ill.

Frank W. Hoyt, '14, is in Company No. 2, New England Division, Plattsburgh Barracks, N. Y.

A. O. de Retana, '14, is employed as an engineer by the municipality of Buenos Aires.

Charles J. Tehle, '14, has accepted a position as chief draftsman of the marine department of the Kerr Turbine Company, of Wellsville, N. Y. Address P. O. Box No. 269, Wellsville, N. Y.

W. L. Maxon, '15, formerly metallurgist with Amalgamated Zinc, Ltd., of Hobart, Tasmania, is now with the Copper Queen Smelter, at Douglas, Arizona. His address is 1165 Tenth Street.

Robert Bartholomew, '15, of 1339 University Avenue, New York, has enlisted in the aviation section, Signal Officers' Reserve Corps, U. S. A., and will train for six months at the government aviation school at Mineola, Long Island.

R. M. Van Valkenburgh, '15, is supervisor of the department of safety and welfare of the American Ship Building Company with office at 622 Leader-News Building, Cleveland, Ohio.

John Morris Binore, '16, of 102 West Eighteenth Street, New York is attending the Officers Training Camp at Madison Barracks, New York.

Lenox R. Lohr, '16, second lieutenant, C. A. C., has been relieved from duty at the Coast Artillery School, Fort Monroe, Va., and assigned to duty in the coast defense at Puget Sound.

Robert H. Chapman, '17, is in the engineering Department of the Locomobile Company of America. He is living at 887 Park Ave., Bridgeport, Conn.

The Sibley College track team yielded first place to Arts in the intercollege track meet on May 26, held in place of the intercollegiates. In spite of the absence of nearly all of the varsity men, the competition was very good. Arts scored 61 points, M.E. 42, C.E. 18, and Ag. 14. Sibley's winners were J. C. McDougall, '19, in the discus throw, and N. E. Elsas, '18, in the high hurdles. The former also took second in the mile run, while the latter placed third in the low hurdles.

The U. S. Aviation school at Cornell has now about 40 recruits and the work of the school is carried on rain or shine. Captain H. G. Davidson, a West Point graduate of the class of 1913, heads the school and has as his assistants Professor Frederick Bedell, '92, Professor F. O. Ellenwood, and Professor L. A. Lawrence in the theory of aeronautics.

Captain G. M. James, '15, W. F. Bull, '16, and W. L. Saunders, '17, are acting as instructors in military science.

S. G. Beckett, '92, was the first Cornell alumnus to lose his life in the great "World War." Colonel Beckett was in command of the Ninety-fifth Battalion and was killed in action last March while leading his men in an attack on the German lines.

Colonel Beckett was a graduate of the Architectural College at Cornell and before the war was engaged in his profession at Toronto, Canada. He enlisted at the outbreak of the war and had seen almost continuous service up to the time of his death.

Mr. Garuel from the "Automatic Electric Company," Chicago, gave several interesting addresses on the "Automatic Telephone," Friday, June 1.

Mr. Grauel demonstrated in a very satisfactory manner, the advantages of the automatic phone and his ability to answer questions helped to convince the Sibley students of the efficiency of the phone. The lectures were all well attended and it is hoped that we may see more of Mr. Grauel in the future.

Professor G. B. Upton of the department of Experimental Engineering has recently started upon a biological expedition, with a party composed of Professors Wright and Bradley of Cornell, and several from other Universities. It is planned to study the wild life of our entire Eastern and Southern borders, paying especial attention to that of the mountains of New Mexico and Arizona. The trip is being made in Ford cars, thus insuring a place for another of the Professor's many hobbies. The machines are to be sold in San Francisco and the return trip made by rail so that the party may be here for the opening of the University in the fall.

Dennis H. O'Brien, '17, was married to Miss Amelia La Fevre, of Anaconda, Montana, on May 8. O'Brien is now in the employment of the Anaconda Company, at Great Falls, Montana.

BOOK REVIEW

The Heat Treatment of Tool Steel, by Harry Brearley. Second edition 1916. 224 pages. Price $3.50. Longmans, Green & Co., Fourth Ave. and 30th St., New York City.

This book was written for the engineer, manufacturer's representative, foreman or trained artisan who might be interested in steels, particularly tool steels. The practical way in which the subject is discussed together with the many microphotographs have enabled the author to produce a work which well fulfills the purpose for which it was intended.

The pleasing way in which the subject is developed has made an easy reading book which ought to interest every engineer and which should offer the student in engineering a means of obtaining some useful information in a pleasant way. The physical-chemical relations and the phase-rule charts, so common in similar treatises, have been eliminated in accomplishing this but all of the important considerations are explained in a more practical way.

The subject of tool steels is treated under the following heads: Structure and Classification, Crucible Steel—Raw Materials, Properties of Ingots, Fractures and External Appearances, Forging Tool Steel. Physical Changes in Steel on Heating and Cooling, The Hardening of Steel, Tempering and Straightening, Hardening Typical Tools, Hardening Plant, Pyrometers, and Alloy Steels. J. F. W.

EMPLOYMENT BUREAU

431. A college in Pittsburgh is reported to be looking for a man to take charge of a course in commercial engineering. The man must have had wide business experience, including salesmanship, manufacturing processes, and finances as related to manufacturing. Engineering experience secondary. Salary $3,000 or more. Apply to Employment Bureau for name of institution.

432. Mr. W. J. Rogers, United Motors Corporation, Suite 1809, Aeolian Buildings, New Yrok City, wants man 35 to 45 years of age as production manager at $3,000–$4,000 or more. Must have had actual experience in shop, drawing room, tool design, die making, etc. Knowledge of design and operating tools for press work essential. Must know efficiency methods, etc. Experience in electrical work desired. Vicinity of New York City.

433. U. S. Civil Service position without examination: No. 966, Electrical Engineer, Springfield Armory, Mass., or elsewhere, $3,000 a year. Write to C. S. Commission, Washington, D. C. for Form 1312 and mention title of position.

434. Mr. L. W. Corbett, chief draughtsman, Niagara Alkali Company, Niagara Falls, N. Y., wants recent graduate for the engineering department. The work includes general plant drafting and inspection of equipment and buildings.

435. Mr. Howard Kellogg, general manager, Spencer, Kellogg & Sons, Buffalo, wants man with five or six years' experience obtained in connection with manufacturing plants. Product is linseed, cocoanut and other vegetable oils produced in crushing plants and subject to chemical treatment in refineries. Knowledge of organic and inorganic chemistry preferred.

436. Mr. W. L. Rogers, United Motor Corporation, Suite 1809, Aeolian Building New York City, wants man as Chief Inspector, at $1,800, to have charge of inspecting force of 15 to 25 men. Prefer man with experience in automobile factory or automobile radiator works. Vicinity of Buffalo.

437. Lieutenant-Colonel B. W. Dunn (Office of Ch. of Ordnance, War Dept., Washington, D. C.), wants recent graduates at $3.50 per day as sub-inspectors on munitions.

438. The Bureau of Steam Engineering, Navy Departmnet, Washington, D. C., has openings for draftsmen, especially for those qualified for marine engine and boiler and electrical work.

439. Mr. N. W. Jones, superintendent telegraph, Philadelphia & Reading Railway Company, Reading. Pa., wants recent graduate to plan and direct installations of telegram and telephone systems, motor generator sets, and storage batteries, prepare specifications for incandescent and arc lighting and supervise construction, locate electrolytic attacks on underground cables, etc.

441. H. L. Griggs, general sales manager, The Bristol Company, Waterbury, Conn. (recording instruments) wants recent graduates to prepare as sales engineers.

442. Mr. J. H. Torney, 2d vice-president, R. Martens & Co., 24 State St., New York City, wants men 22 to 28 years old, unmarried, with knowledge of some foreign language, to go to Russia and after a year or more of study of conditions assume responsible positions. "The opening for these men is one of the finest which I can imagine." Men wanted for fields of oil well operation and oil manufacturing, road making (macadam, etc.), metallurgy, agriculture and dairy farming, and steel plant or large foundry with knowledge of machine tools.

443. Mr. Jas. D. Grant, 3650 S. Leavitt St., Chicago, Ill., wants man to take charge of shop school of International Harvester Company and spend half time on design of tools and special machines. One hundred dollars per month to start.

444. Prof. John P. Kottcamp, head of mechanical laboratory, Pratt Institute, Brooklyn, wants recent graduate, with one year's practical experience, as assistant in mechanical laboratory, $1,200 salary.

445. Mr. A. J. Liebmann, general manager, Independent Lamp & Wire Co., Weehawken, N. J., wants recent graduates in electrical engineering and chemistry. Manufacturers of Tungsten lamps and tungsten products—several departments offer good opportunities.

446. Mr. J. N. Pew, Jr., '08, vice-president, The Sun Shipbuilding Company, Camden, N. J., wants recent graduates and men experienced in various branches of shipbuilding.

447. Commandant (Captain) C. F. Thompson, is enlisting men for a Cornell Battalion of Enlisted Reserve Signal Corps (mounted). Age limits 18 to 45. The men will be trained in telegraph, wireless, semaphores and wigwag signalling. Men needed as veterinarians, motor cyclists, gas engine operators, clerks, cooks, etc.

449. Mr. A. W. Seacord, '09, Osborne Works, International Harvester Company, Auburn, N. Y., wants recent graduate to train for executive position in manufacturing.

450. Prof. W. A. Hamor, Assistant Director, Mellon Institute, University of Pittsburgh, Pittsburgh, Pa., has vacancy in industrial fellowship. Mainly experimental steam engineering. Stipend not less than $1,800 to start. Man must be especially gifted in experimental physics and engineering and have good personal qualifications.

451. Mr. M. W. Kellogg, president M. W. Kellogg Company, 90 West St., New York (engineers and contractors), wants technical man to start in estimating department. Wants absolutely first class man.

452. It is reported that Sanderson and Porter, Gray's Harbor, Wash., want many men in connection with construction of wooden ships.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI AUGUST, 1917 No. 11

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN P. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year

Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 5th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR AUGUST, 1917

The Directory Number

The September issue of THE SIBLEY JOURNAL is to be the directory number of all the Sibley alumni. It will have three independent lists; alphabetical, geographical and a list of the deceased attendants of Sibley College. The files were closed for information for this number in the latter part of June, but, if any one has information regarding former Sibleyites, we would appreciate the favor very much if they would send it to us. We are very anxious to keep our alumni files as nearly correct as is possible.

UNIVERSITY NOTES AND PERSONALS

Major F. A. Barton, '91, is in Youngstown, N. Y. on a four months' sick leave.

Emmett B. Carter, '99, is president of the Engineers' Club of Philadelphia, and his presidential address appears in the June issue of the proceedings of that society.

Ralph S. Cooper, '03, formerly manager of the New York office of the Independent Pneumatic Tool Company, Chicago, Ill., has been elected vice-president of the Company. Mr. Cooper was formerly one of the editors of THE SIBLEY JOURNAL.

H. E. Epley, '03, is secretary and superintendent of the Maydrite Products Company, Jersey City, N. J.

Walter W. Wood, '03, is a tool designer with the Holmes Automobile Company. His home is at 224 N. W. 14th street, Canton, O.

E. J. Blair, '05, has received a captain's commission in the Engineers' Reserve Corps and is assigned to active duty at Fort Leavenworth, Kansas.

J. J. Conen, '07, is in charge of the shop practice of the Mount Clare shops of the B. & O. R. R.

Stafford Montgomery, '09, has qualified in examinations for Major in the Ordinance Officers' Reserve Corps. He will probably be temporarily detailed to the Rock Island Arsenal with a subsequent transfer to some private plant in the Chicago District.

C. E. Thomas, '13, is an experimental engineer with the General Engineering Company of Detroit.

A. A. Gazda, '14, who is in the Engineering Department of the Westinghouse Electric and Manufacturing Company at Pittsburgh, recently contributed a paper before the mid-winter convention of the A. I. E. E. on "The Performance of Polyphase Induction Motors under Unbalanced Secondary Conditions." An article on "Methods of Speed Control and Dynamic Braking"

(Continued on page 233)

THE ENGINEER AND THE PHYSICIST

F. K. RICHTMYER*

The article by Dr. Buckingham on "The Relation Between Physicists and Engineers" in the July number of THE JOURNAL points to a condition which needs study and suggests a number of items for careful thought. Any discussion of this question, however, must be prefaced by a statement relative to the status of Physics among the sciences.

The science of Physics is unique among sciences in that it holds as it were a central position around which are grouped other sciences and technologies. The botanist, for example, considers that he has solved a question of plant life when he has reduced his observations to the phenomena of capillarity or osmotic pressure. It is for the physicist to explain what these things are. The physiologist has given a satisfactory explanation of vision when he has reduced light action on the retna to certain combinations of physical processes which again must be explained by the physicist. A new branch of engineering is developed when the physicist has made a new fundamental discovery. Since Physics is so closely related to all these sciences and technologies it has obligations not only to engineering but all other sciences as well.

It is obvious, therefore, that, even were the physicist inclined to do so, it would be unwise for him to confine his attention to the investigation of problems which have a bearing, direct or indirect, upon engineering alone.

If any lack of co-operation exists between the engineer and the physicist it is largely because of mutual misunderstandings. It is more than likely that the desired co-operation will come automatically if these misunderstandings and misconceptions of each others ideals and spheres of activity are cleared up and it is probable that the solution of this difficulty must start in the University.

The engineering student gets his notion of subjects other than engineering mainly in his college course. This applies particularly to Mathematics, Chemistry and Physics. If he is to retain at the end of his course and in the early years of his practice a healthy attitude toward these fundamentals of engineering he must see their usefulness during the time that he is a student. This again simply means increased co-operation between the teachers of these several subjects and engineering rather than any specific change of subject matter or method of teaching.

It is a curious fact that Physics is universally regarded by students of engineering as a particularly difficult subject. This is borne out very strikingly by the investigations of Dr. C. R. Mann under the auspices of the Carnegie Foundation for the Advancement of Teaching. Dr. Mann finds on analyzing the grades received by graduates of a large number of engineering schools that the average grade in Physics is lower than that in any other subject. It is difficult to believe that this low grade is due to poor teaching and yet it is difficult to see why the subject matter of Physics should be for an engineering student any more difficult intrinsically than the various engineering subjects which follow Physics and which are in large part based upon Physics. Yet in these the student makes a more creditable showing.

It is probable that a part of the difficulty which the student experiences in the study of Physics comes from the lack of appreciation of the fundamental importance which the subject plays in subsequent work in engineering. This attitude is in part a natural one for we all find difficulty in concretely realizing something which is put to us as a seeming abstraction. The student may be told in his freshman year by his instructors that the work which he is then taking is to prepare him for subsequent courses. But there is a tendency not to appreciate the significance of this warning until those subsequent courses are reached. And if it so happens that the instructors in these subsequent courses approach the subject matter from an entirely different viewpoint without properly co-ordinating and dovetailing their own work with that of the previous year, the student may have reason for believing that his freshman instructor has been a false prophet. If so, the coming freshmen class will surely hear of it and there will be an added reason why the freshman or sophomore takes the work of these fundamental subjects a little less seriously.

I believe that the whole matter is largely one of providing proper co-ordination and dovetailing of the various courses throughout the whole curriculum and in providing proper sequences so that a student taking Physics, for example, will not assume that he has finished studying Physics when he has passed the requisite number of hours in his freshman or sophomore year. If the teachers in subsequent engineering courses which supposedly base their subject matter upon Physics are thoroughly and intimately acquainted with the material given in the Physics courses and with the way in which this material is presented, I believe that many of the difficulties which the engineering student has with Physics will disappear. Furthermore, it is much easier for a student to remember a number of facts or principles put in proper sequence and intimately related to each other than to remember or grasp the same number of isolated facts or principles apparently unrelated to each other.

There are to be sure many pedagogical problems before the teacher of Physics which have never been discussed. The duty of solving these problems

*Professor of Physics, Cornell University.

lies quite as much with the engineer as with the physicist. When the present emergency schools of aviation were established, practical aviators were consulted as to the content of the course. But I believe that few engineering or scientific societies take very seriously their obligations in giving assistance in the solution of purely pedagogical problems. Many of them are like an army so absorbed in its own maneuvers as to forget the extreme importance of the recruiting station. From this standpoint it is interesting to examine the recent report of the Committee on Teaching Physics to students of Engineering as presented to the Society for the promotion of Engineering Education. This report contains much interesting material which can best be given verbatim. The object of the Committee was if possible to get a summary of the attitude of three classes of persons toward the relation of Physics to Engineering: (A) teachers of Physics; (B) teachers of Engineering; (C) practising engineers. In order to obtain such opinions questionnaires were sent to each of these three classes respectively, questionnaires A, B, C. In all, over one thousand sets of questions were distributed. The following is quoted from the report:*

QUESTIONNAIRE *C*

Answered by Practising Engineers

By means of questionnaire *C* it was hoped to obtain the opinion of practising engineers regarding the teaching of physics. While answers have been received from only 24 persons, yet many of these are eminent professional engineers and occupy important official and public positions.

1. *What are the criticisms of the teaching of physics, as observed by you?* Fifty-two per cent. of the replies contained no comments on this question; the criticisms of the others are more or less general in character, and for convenience in this report they have been combined with the answers to question 5 (*d*).

2. *Do you think the amount of laboratory work, as usually given, is sufficient?* Sixty-two per cent. of the practising engineers vote that the time generally allowed for laboratory physics is sufficient.

3. *Should the calculus methods be used in general physics courses?* Sixty per cent. of the practising engineers say that calculus should be used. Individual opinions in abstract are:

"No, because calculus is poorly taught."

"Calculus greatly simplifies the subject and gives the student a clear understanding of physics."

"The physics course should be physics and not mathematics."

"I am very strongly of the opinion that if we are talking about the department of physics as differentiated from the physics of other departments, such as mechanics, then I believe that the emphasis should be laid upon the physical concept rather than upon the mathematical demonstration."

4. *Are the mathematical and theoretical aspects of physics of value to the engineer?* Ninety-five per cent. of the practising engineers vote "Yes," with emphasis.

5. *In the light of your experience, what changes would you think desirable in the education of the engineer as to:*

(*a*) *Time spent in studying the fundamental sciences as compared with time spent in studying the technology of engineering.*

(*b*) *Method of presenting work in physics.*

(*c*) *Subject matter taught in physics.*

(*d*) *Other items relating to this general subject.*

(*a*) One hundred per cent. of the practising engineers vote that more time should be spent in studying the fundamental sciences. Various individual opinions are as follows: The best results will be obtained by teaching soundly the fundamentals, such as the natural sciences, mathematics, and languages.—Science is fundamental, technology should be used only for illustration.—Give maximum time to fundamentals; technology will be readily acquired later.

(*b*) There are no definite criticisms of the methods of presenting work in physics except such as are noted under (*d*).

(*c*) There is a general request for an increase in the subject matter relating to the fundamentals of physics.

(*d*) Many interesting remarks were made under this number, some of which are as follows: The strongest impression I have gained from experience with many college men is the lack of full understanding of simple and fundamental principles; it isn't uncommon to find a man who remembers a catalog of engineering facts but falls down on relatively simple problems, because he lacks knowledge or faith, of simple laws, such as the conservation of energy.—The greatest technical deficiency of young engineers is in connection with applied mechanics.—More systematization is needed in teaching physics.—The student looks upon college physics as a supplementary high-school course; he does not realize that all engineering is built upon four fundamental courses of mathematics, physics, chemistry and mechanics; for this the student is not to blame, the engineering professor fails to inform him properly.—Engineering courses as a whole err greatly in too much technical specialization; I hope the day will come when all colleges will have a four-years course in engineering, without classification, with added graduate courses of one or two years in which special courses are taught; I would double the time spent on mathematics, physics, chemistry, and mechanics.

Keep putting the students to the test! There is no use in taking up advanced matters until the student can actually handle the fundamentals with real intelligence.—In a college course in engineering, we should constantly keep in mind that the man who graduates will still have to learn his profession as a specialist after graduation.—Courses and methods should vary to suit the student's individual aptitude; there should be a general course which everybody can pass, and further courses for those who can pass them easily; those who cannot should not be made to pass in spite of inaptitude.—Civils should not be compelled to waste their time on such topics as electrical theories and measurements or entropy and allied subjects.—One of the greatest mistakes made by colleges is allowing instructors who have simply made rank in their courses to take up on graduating the teaching of students, without practical experience and without knowledge of the principles of teaching or of class-room work except as practised upon themselves; in some cases this amounts actually to cheating the students.—I believe the fundamental sciences should be differently treated for different engineering groups; more of the historical side of the evolution of physics should be given to bring out the out the essentials of original research; a practical attitude should consider accident prevention, or the danger involved in the disregard of physical laws.—An excellent textbook should be used and the professor should spend a goodly part of his time in lectures, laboratory should be collateral to this; practically no time should be given to teaching technical applications; the man who is firmly grounded in a few of the fundamentals has an excellent basis for further development.—College training should deal thoroughly with fundamentals, and in a descriptive and inspirational way with engineering technology; fundamentals can be learned readily in college and with difficulty afterwards, while the reverse is true with respect to engineering technology.

Teaching of physics is not practical; too much ground is covered; material given on electrostatics, electricity, magnetism, etc., is usually not understood by the instructor, this material should be omitted entirely from physics designed for engineering students. Hours are spent in studying calculus, physics, machine design and other technical subjects, where minutes

*See "Proceedings of The Society for the Promotion of Engineering Education," vol. xxiv (1916).

are spent on English; in proportion to their importance after graduation this order of things should be reversed.—Correct theory is always of value, and if theory is mastered, practice must necessarily follow; fundamental sciences should not be neglected for specialization in any line, for so much that is met with later must go back to fundamentals for solution.—Too often the teachers are narrow specialists, possessing little knowledge outside of their limited field, and their experience is confined to the class-room, laboratory, and the social activities of the college campus and some religious organization; and their outside reading frequently consists of such material as popular novels, a local daily, the sporting news, and *The Ladies' Home Journal*.

Teachers should be men of broad knowledge and wide practical experience, capable of giving illustrations of the application of scientific principles, and thus greatly stimulate the interest of the student. Get the student into the habit of thinking, he is educated only in proportion to his ability to think. A final examination which cannot be given, permitting the student free access to all the volumes of a library, is worthless.—Physics is one of the fundamental sciences for the electrical engineer, and the more the design engineer, the works engineer, and the commercial engineer know of physics, the better able will they be to answer the many questions which arise in connection with their work. The mathematical and theoretical aspects of physics are of great value to the engineer; we would rather have the college man study the fundamental sciences very thoroughly, than to specialize along some line of engineering.—The instruction is too "scholastic."—The teacher gives too little time to his classes.—The instruction is too dry and lifeless; it should encourage the student to think, question, and investigate.—Too much ground is covered.—Too much lectures; too much recent theories; too much use of the metric system; too many useless terms, as the poundal, slug, etc.; lack of experiments on heat.

QUESTIONNAIRE *B*

Answered by one teacher of physics and teachers of various engineering subjects in each college.

Questionnaire *B* was designed to furnish information in regard to certain specific matters relating to the teaching of physics, as viewed by the teacher of physics, and by the teachers of various branches of engineering in the same institutions.

1. *Should instruction in general physics include such subjects as dimensional equations, black-body radiation, radio-activity, X-rays, etc.?*

The answers have been analyzed to show the affirmative vote of the physicists from fifty-seven institutions, the engineers from the same institutions, engineers from other institutions, and the average of all votes.

	Dimensional Equations.	Black-body Radiation.	Radio-Activity.	X-Rays
Physicists	60%	67%	74%	80%
Engineers in same institutions	55	58	58	55
Other engineers	50	48	56	56
All votes	54	57	03	63

2. *Do your students in engineering take advanced courses in physics in addition to the regular prescribed courses? What is the attitude of the engineering faculty in the matter?*

Advanced courses are taken in 27 per cent. of the institutions, while 80 per cent. of the physicists and 40 per cent. of the engineers vote in favor of such courses. The reason almost invariably assigned for a negative vote is that there is no time that can be given to advanced courses.

3. *Should calculus be a prerequisite to the course in general physics? Should calculus methods be used in the instruction in physics?*

Of the teachers of physics, 31 per cent. think calculus should be a prerequisite to the course in general physics, and 45 per cent. think calculus should be used in the course; 36 per cent. of the teachers of engineering think calculus should be a prerequisite, and 60 per cent. think it should be used in the course; 60 per cent. of the practising engineers vote for the use of calculus in teaching physics. The remarkable feature of this vote is that 60 per cent. of the practising engineers think calculus should be used in physics, while 55 per cent. of the teachers of physics think it should not be used. The reason assigned for not using calculus is that it is impracticable to arrange the schedule so that calculus can be taken before physics.

4. *Should different courses in physics be given to different groups of engineers, as architects, electrical engineers, etc.?*

Eighty-seven per cent. of the teachers of physics and 85 per cent. of the teachers of engineering vote against differentiation. The opinions on this question are very emphatic: Yes; sound is more important to an architect than to an electrical engineer. —I strongly favor the giving of different courses.—No; the best course in physics is none too good for any of them, and each deserves the best.—Decidedly not!—There is some sense in segregating boys and girls in high-school physics, and general students from engineers in college, but none in segregating the various groups of engineers; there is enough probability that they will be narrow, without encouraging it.—Physics should be studied as a science with especial reference to physical explanation of phenomena, and not as a mere vocational subject. —On no account!—The student should know the physicists as such, and become informed of the things that the physicist has uncovered; the work should be subjective, staying just as close to nature as possible, omitting as little as possible.

QUESTIONNAIRE *A*

Answered by teachers of physics.

Questionnaire *A* was sent to one teacher of physics in each of 63 different institutions, and answers were received from 57 of them.

2. (*a*) *What is the minimum time given to instruction in physics, by lectures, by recitation, and by laboratory practice?* (*b*) *In what year does this work come?* (*c*) *In the light of your experience do you recommend a different schedule?*

The purpose of this question was to ascertain with how little physics a student may be graduated from any course in the engineering department of a college. Most institutions, as shown by Question *B-4*, give the same amount of physics to all, while in a few cases there is a great variation in the amount required. Three institutions report that students may be graduated who have had only 4 semester-hours of lectures and recitations and 4 semester-hours (actual time) of laboratory practice; and in one instance only 2 actual hours per week for one semester is required in the laboratory. Thirteen colleges require 6 semester-hours, or less, of lectures and recitations, while 21 colleges require 10 semester-hours or more. Of the thirteen colleges requiring six semester-hours or less of lectures and recitations, two are in Ohio, one in Indiana, and the others are in the southern or far western portions of the country Sixty per cent. of the institutions are satisfied with their present schedule arrangements, which, on the average, allow 9.3 semester-hours for lectures and recitations and 7.5 semester-hours (actual time) for laboratory practice. Forty per cent. of the colleges wish an increase in time, the average at present being 7.5 semester-hours for lectures and recitations, and 7.9 semester-hours (actual time) for laboratory.

The instruction in general physics is given in the sophomore year in 58 per cent. of the institutions; 22 per cent. give the instruction partly in the freshman and partly in the sophomore years, and 20 per cent. give it in the sophomore and junior years.

3. *Do those who have had preparatory physics take courses different from those who have not? Does preparatory physics materially help the student's progress?*

Seventeen per cent. of the institutions give a different course in physics for those who have had preparatory physics, from the course given for those who have not. Seven and seven-tenths per cent. say that the preparatory course is beneficial, though this sentiment is very mildly expressed; one single report says that the preparatory course retards the student's progress.

5. *In case your institution has an academic department, is physics (for engineering students) taught in it or in the engineering department?*

In 21 per cent. of the institutions physics is taught in the engineering department as distinguished from the academic department of physics.

6. *What steps are taken to secure continuity of subject matter between physics and the several subsequent engineering departments for which physics is supposedly a prerequisite?*

In 60 per cent. of the institutions, some effort is made to secure continuity between the subject of physics and the following engineering courses. There seems to be no definite method of securing this result except such as is described by the words "consultations," "conferences," "correlation," etc. Forty per cent. of the institutions report that no organized effort is made to secure continuity.

General Recommendations

The study of these questionnaires leads the Committee to make the following general recommendations as tending to the highest efficiency in the teaching of general physics to engineers. The Committee appreciates the fact that some of these recommendations are inconsistent with existing conditions at certain institutions, and that under these special conditions other specifications may be more acceptable.

1. Preparatory physics should be required for entrance upon any engineering course.
2. The course in college general physics should be the same for all groups of engineering students, and it should be under the supervision of the general department of physics of the college or university.
3. The increased use of higher mathematics in developing the fundamental theory of general physics, including the use of the methods of elementary calculus, will be advantageous to the engineer.
4. In order to secure the benefits mentioned in paragraph 3, the course in physics should not begin until the student has had training in elementary differential and integral calculus. As the schedules are ordinarily arranged, physics would then begin about the middle of the sophomore year. It is usually thought best to begin physics with the sophomore year, sacrificing the advantages to be gained by the use of the calculus. To begin physics in the freshman year would still further sacrifice the use of mathematical principles, and this should be avoided. It is possible that a rearrangement of mathematics schedules will make elementary calculus methods available at the beginning of the sophomore year, a condition much to be desired.
5. The minimum time suitable for the course in general physics is 10 semester-hours for lectures and recitations accompanied by 9 semester-hours (actual time) of correlated laboratory practice.
6. The course in general physics should cover the entire subject matter, including sound and light. Such subjects as dimensional equations, radio-activity, black-body radiation, X-rays, etc., should be included, but should be treated very briefly. The greatest emphasis should be placed upon the obvious fundamentals of the science, and the technology should be used for illustrations.
7. The course in physics should be correlated to the work of the preceding courses in mathematics and to the following engineering courses by definite methods adapted to particular faculty organizations.

It would be very beneficial if the time given to general physics could be greatly increased, and if the instruction could begin at the middle of the second year and extend through the third year. In this scheme, calculus could be a prerequisite to physics, and calculus methods could be used in physics, which would facilitate the work, and would tend to make a more powerful analytical engineer, one who could *use* higher mathematics as a real, working tool. This suggestion might be practicable only with a five-year course for engineers. There is reason to think that the present educational tendency is in this direction.

The practising engineers are very emphatic and almost unanimous in their appreciation of the mathematical and theoretical aspects of physics, and they urge in the strongest terms that more time be spent in studying the fundamental sciences even at the expense of time now given to the study of the technology of engineering.

The Committee hopes that these results will be of some influence in the rearrangement of schedules whereby physics may be given a better opportunity to prepare the students for engineering work; and the more so, since the deficiencies in physics seem to be largely due to the lack of sufficient time for the proper mastery of so broad a subject.

Some of those who read these recommendations may disagree with some of them. The question of utmost importance, however, is that these matters should be discussed and teachers of Physics and of Engineering should realize that here is a problem worthy of quite as much attention as the design of a new machine or the discovery of a new physical law. We hear in these days much about efficiency and the elimination of waste. Waste of time and energy which can be eliminated simply by proper co-operation and co-ordination is unpardonable.

It is to be hoped that engineers and teachers of engineers will discuss the importance of this all-important question particularly on the basis of the report quoted above.

UNIVERSITY NOTES AND PERSONALS

(*Continued from page 229*)

in the April number of The Electric Journal was also written by Mr. Gazda in collaboration with H. D. James.

V. B. Phillips, '15, has been recommended to the War Department as a first Lieutenant in the Engineers' Reserve Corps and is stationed at Fort Leavenworth. He presented a paper at the spring meeting of the A. S. M. E. on "Efficiency Tests in the Boiler Room."

J. F. Wait, '16, M.M.E., '17, is employed by the Hooker Electrochemical Company at Niagara Falls as a chemical engineer. At present he is working in their research department.

C. M. Bomeisler, '17, is assistant manager of the Waycross Packing Plant, Waycross, Ga.

The Forty-ninth Annual Commencement took place during the week of June 22 to 27. The usual Senior Week festivities were markedly absent. Everything showed the effects of the great world struggle. Out of a graduating class of twelve hundred, but a few over two hundred remained to take part in the exercises. One could easily guess that the absentees had left to serve the country in some manner or other. A few of those present were back from the army and navy training camps, and their uniforms lent more solemness to the occasion.

The Baccalaureate service was held on Sunday, June 24, in Bailey Hall. Rev. C. W. Gilkey, of the Hyde Park Baptist Church, Chicago, and now Chaplain of the R. O. T. C. camp at Fort Sheridan, delivered

(*Continued on page 12 ad.*)

MOTION-PICTURE DEVICE FOR TESTING CAMERA SHUTTERS

*EDWIN A. HUNGER, '11

A one-hundredth part of a second, which is frequently taken as an average camera exposure in sunlight, is indeed a very small period of time—one's senses fail absolutely to grasp it in its true proportions; but carry this one-hundredth of a second ten times further, then carry it thirty times further still and the division is so infinitesimal that one's mind becomes hazy at the mere thought of it just as it fails to perceive the enormous distance that exists between stars and planets. Yet this very minute time interval—only 1/30,000 second—is sufficient to make an exposure on a motion-picture film of a rapidly moving camera shutter, which shows the position of the shutter at a one-thousandth-second period, with a testing outfit developed in the Research Laboratory of the Eastman Kodak Company and shown herewith.

Twenty small mirrors are mounted on the rim of a wheel or crown as shown to the left in Fig. 1 which is rotated at a constant speed of 50 revolutions per second by a specially governed motor. An arc lamp is inclosed in an ordinary projection lantern, the condenser of which focuses an image of the arc crater at the surface of each mirror as the wheel is rotated. The light which is reflected passes through a simple lens back of which is placed the shutter to be tested. An image of the shutter is then formed by a small camera lens on the rim of an aluminum wheel 12 inches in diameter which is turned by a handle as shown and around which is fastened a band of motion-picture film. The motion-picture wheel is shown to the right in Fig. 1 with cover removed.

Since the wheel containing the mirrors rotates fifty times a second and there are twenty mirrors there are 1,000 interruptions of the arc lamp beam per second. The light from the lantern passes through a narrow vertical slit before impinging on the mirrors. This slit reduces the angular width of the light flashed through the shutter to one-thirtieth of that of the angle subtended by one mirror. The time of exposure is therefore one-thirtieth of a thousandth or one-thirty-thousandth of a second and a flash is made every one-thousandth of a second. The motion-picture wheel is enclosed in a light-tight box which can be readily removed and taken to a darkroom for loading and development.

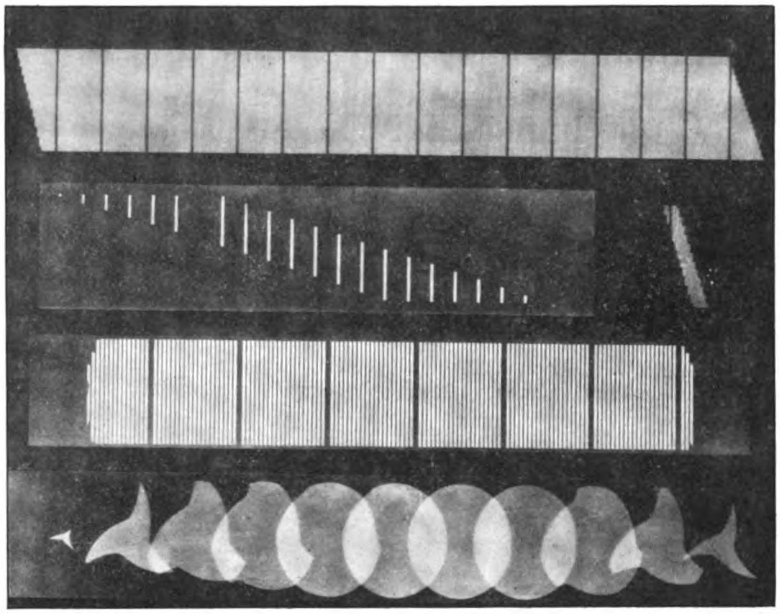


FIG. 2, 3, 4, AND 5. EXPOSURES TAKEN OF BETWEEN-THE-LENS AND FOCAL-PLANE SHUTTERS, SHOWING THE CONDITION OF EACH SHUTTER EVERY THOUSANDTH OF A SECOND THROUGHOUT THE PERIOD OF OPENING

In Figs. 2, 3, 4, and 5 are shown some very interesting photographic records of shutter tests. Fig. 2 illustrates the position of a between-the-lens shutter opened for one one-hundredth of a second at one-thousandth-second intervals. It shows that on release four one-thousandths of a second were required to come to a full opening, that the shutter was fully open another four one-thousandths of a second, and that the shutter finally closed in three one-thousandths of a second. The photographs show, therefore, that although the opening was nominally to be for one-hundredth of a second the shutter was really open eleven one-thousandths second. By measuring the areas of the various openings photographed the efficiency of the shutter can be computed.

Fig. 3 shows exposures taken with another between-the-lens shutter, opened for one-fifth of a second.

(*Continued on page 8 ad.*)

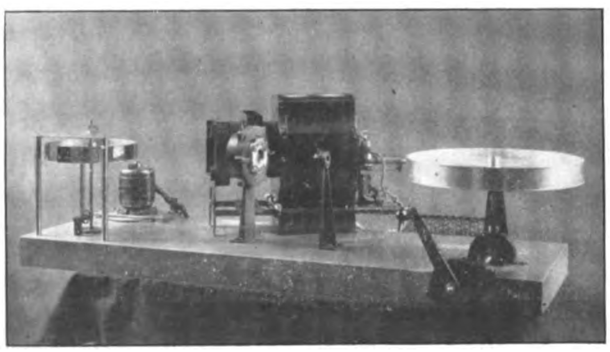


FIG. 1. APPARATUS FOR TAKING EXPOSURES ON MOTION-PICTURE FILM OF ONE-THIRTY-THOUSANDTHSECOND DURATION OF A CAMERA SHUTTER OPENING AT INTERVALS OF ONE-THOUSANDTH SECOND

*With Eastman Kodak Company, Rochester, N. Y.

THE PAPER INSULATED CABLE FOR THE TRANSMISSION OF POWER

BENJAMIN F. LEE*

It is something like twenty-three years since the paper insulated lead incased cable began to be recognized as a decided step forward and began to take its rightful place over other systems of insulated power conductors which had been in vogue prior to that time. Wooden conduits or paper tubes laid in tar boxes into which had been drawn rubber insulated or bare cables were unreliable, and sooner or later went up in smoke. The gradual increase in voltage of the power to be transmitted made some other system necessary. Since that early date in the history of the paper insulated cable, a great deal has been accomplished in standardizing materials that go into the manufacture of these cables so that today, instead of having but one or two companies in this country who are thoroughly reliable manufacturers of such cables, we have now not less than seven companies manufacturing paper insulated cables for the transmission of power at voltages ranging as high as 25,000 volts and higher.

There are, perhaps, few articles manufactured that require greater care and vigilance on the part of the manufacturer than is required to produce a first-class paper insulated lead incased cable. The maker must understand the grade of manila paper he is to use. This paper, which is made from manila fiber, must have certain strength, be free from moisture and run even in thickness. It must have a certain porosity to be able to take up the proper amount of resinous oil with which it is impregnated. It is this oil that serves the double purpose:

FIRST: Of sealing the pores in the paper itself and between layers, and in this way gives the cable great dielectric strength.

SECOND: Of producing a medium for conducting out to the surface the heat set up in the conductors, which function is very important as those who are familiar with such cables are aware.

This resinous oil must be free from dampness, as the least dampness will lower the dielectric strength of the cable. Again, if the oil is stiff the cable is stiff and not pliable, where, if the oil is more fluid, the layers of paper can slide one upon another and thus retain pliability and dielectric strength. It is very important that the paper be wound uniformly and tight, yet thoroughly impregnated, for if there are dry spots in the paper, or voids not filled with oil, where the paper will eventually become comparatively dry, due to the evacuation of the oil, then at that point we may look for a hot spot because the medium for carrying away the heat is not there. The dielectric strength is lowered causing larger dielectric losses at that point.

These hot spots may exist in all stages up to the point where carbonization of the paper is set up. At this juncture, or shortly thereafter, trouble appears and the cable will break down.

Lead insulated paper cables, when going through the process of manufacture, after impregnation, are passed through the lead press and the lead covering spread over them. They are then cut off in lengths, as designated on the customer's order. At this juncture it is important that the ends of the lead covering be sealed up just as soon as it is cut off, in order that the oil may not leak out, leaving a void or air bubble within the lead covering, which will have a tendency to start a hot spot. When the cable is shipped to the customer great care should be taken in unloading from the cars and distributing the reels along the streets. Before the various lengths are drawn into the ducts, the ducts should be properly mandrilled and cleaned out so that no loose materials are left in the ducts, and to determine that the ducts are laid straight, a mandrill slightly larger than the cable should be used. It should be remembered that a sharp piece of granite, as large as an acorn, or anything capable of abrading the sheath if left in the duct, may ruin the lead sheath on a 500 foot length of cable by cutting through the lead and allowing dampness to get to the paper which sooner or later breaks down at that point.

When the cable lengths have been drawn into the ducts, the ends should be examined to make sure that the seals have not been broken, allowing the oil to escape. The cable splicer forms the cable in the manholes, putting them on racks. He gives them easy bends, being careful not to kink them. He then has the splicing material ready and removes the lead casings from the two ends of the cable, makes up his joints, wipes his lead sleeve over the joint and fills it with the joint compound which is put in at a temperature just below the point where the paper would carbonize. This high temperature drives off the dampness that has accumulated from handling after the seal was broken. This hot compound settles into the ends of the cable gradually. The orifice in the lead sleeve is left open for about half an hour, giving time for the hot compound to settle into the cable. At the end of that time it is filled up again and the orifice soldered up.

The function of the joint compound is to properly insulate the joint and fill the void produced by the splice after the air has been forced out through the

*With Hydraulic Power Company, Niagara Falls, N. Y.

orifice in the lead sleeve. This joint compound must also be capable of uniting with the oil in the cable without lowering the dielectric strength of the cable.

The writer recalls one case where several miles of 12,000 volts, three conductor, lead armored, paper insulated cable had to be replaced at the expense of a great many thousand dollars on account of the trouble spoken of above. Tests were made that showed conclusively that either oil or compound tested separately up to comparatively high temperatures, were, of themselves permissible, yet, when they were in union, they had a critical break down point comparatively low in temperature, which made the reinstallation of the cable, as spoken of above, necessary.

Within the last ten years varnished cloth has been substituted in some cases for paper in the manufacture of cables. However, during the past two years, the rapid advance in the price of linen and cotton over that of manila paper, has made its use at present almost prohibitive. In fact, there are special cases only where the varnished cloth could be used with advantage over paper, such as vertical sections where paper cables could not be made oil tight. The fact that paper cables can be operated at higher temperatures than cloth cables is also to their advantage.

In this connection the writer recalls one case where power was being delivered to a customer three miles from the generating station over 7—4—0, 3 conductor cables at 12,000 volts. The cables were insulated with six-thirty-seconds inch paper around each conductor with a six-thirty-second inch paper belt around the three conductors and one-eighth inch lead sheath, all seven cables in parallel at both ends of the line, when a short circuit tripped out the circuit breakers on six of the cables, but, due to a defective circuit breaker on the seventh cable, it did not open. The seven cables were delivering the customer 21,000 KW at the time when the six breakers opened so that the seventh cable still in circuit tried to deliver the whole load. The operator overlooked the fact that he still had one cable in service and did not discover the condition until 17 minutes later when the seventh cable was tripped off. The Graphic Kilowatt Meter on this load showed that when the six breakers opened, leaving but one cable in service, the load fell abruptly from 21,000 KW to 18,000 KW and for the next 17 minutes tapered down to 9,000 KW where it was tripped off. A normal load for one of these cables in the conduit when surrounded by other loaded cables at that time of year (July) was about 3,000 KW; so it will be seen that this cable started off with 600 per cent full load and tapered down to 300 per cent load after 17 minutes, the tapering off of load being due to increasing resistance with increasing temperatures.

It is not known what extreme temperature the conductors in the seventh cable attained, but it must have been far above the boiling point. About 15 minutes after the cable was switched out of circuit a workman was burned severely enough to cause a blister when his wrist came in contact with the lead covering, and about half an hour after it had been switched off one could hardly have touched the lead. An inspection of the 53 joints in this cable showed that 22 of them had been broken open, due to the expansion in the joint compound and cable oil, and were leaking badly, gas or smoke coming out of some of the breaks. The breaks took place in the joints because of their large diameter and consequently were weaker than the smaller diameter cable sheath. The writer, after noting the condition of the cable, and having an opportunity to feel of it, after the lapse of half an hour, becoming skeptical of its further usefulness, had a piece cut out and examined the paper from the lead sheath to all three conductors. He was agreeably surprised to note that the first layer of paper next to the copper was not even discolored and was as fresh and pliable as new. The 22 joints were repaired and this cable put in service the following day. Nearly four years have elapsed since the above occurrence and this cable has done its full part along with its neighbors, seemingly none the worse for its hard experience.

In the middle west some 22 years ago the writer had to do with the installing of a paper insulated, three conductor, lead incased cable nearly 12 miles in length. This cable was designed to operate at 12,000 volts and it was said that it was the longest cable to operate at such high voltage that had been installed up to that time. We had at that time no high potential test transformer wherewith to test the cable when installed, as is the general custom now. We simply built up one generator with its step-up transformers connected to the cable, and in this case we used to run the voltage up to only 15,000 volts, 3,000 volts above normal, which was not much of a test after all. The writer recalls that this cable broke down five or six times before it would stand its normal voltage, 12,000 volts, and, as I remember, it was three or four weeks before we got a continuous twenty-four hour run out of it without a break down at its normal pressure of 12,000 volts. It seemed that this cable would never stand. The breaks, however, became fewer with age and last July, something like twenty-one years after this cable was first installed, since I was in that city, I took the occasion to inquire what had been done with this old cable, and was surprised to learn that it was still doing business and that it had given no trouble for more than a year. I was also informed that this cable was now operating at 13,200 volts instead of 12,000 volts, for which it was first designed.

In the manufacture of three conductor, paper insulated cables for 12,000 volts working pressure with six-thirty-seconds inch paper around each conductor and a belt of six-thirty-seconds inch paper around the three conductors it is customary to apply a test voltage in the factory of three times normal, or 36,000 volts, both between the conductors and from the con-

(*Continued on page 12 ad.*)

EMPLOYMENT BUREAU

453. Mr. Louis C. Eitzen, general manager August Mietz Corporation, 128 Mott Street, New York City, wants mining engineer with some knowledge of chemistry and accounting to take charge of magnesite quarries in Venezuela. Must be American, speak Spanish, and have thorough knowledge of Latin America and peculiarities of natives. One hundred fifty to 300 native laborers. Salary possibly $300 per month.

454. Mr. W. S. Field, 226 Devonshire Street, Boston, employment manager for a large Boston manufacturing organization desires engineer of experience, who is specialist on power, heat, light and ventilation, as head of department offering excellent opportunities. Must be man of excellent personal qualifications.

455. Mr. A. Conti, marine engineer, U. S. Shipping Board, Emergency Fleet Corporation, Munsey Building, Washington, D. C., wants marine and hull draftsmen of experience. The need is urgent.

456. Mr. T. O. Hussey, '12, National City Bank of New York, New York City, wants recent graduate for engineering work connected with banking business. Efficiency work, industrial projects, etc.

457. Mr. F. Bissell, The F. Bissell Co., 226 Huron Street, Toledo, O., (electrical repairing) wants experienced man to run repair department; also recent graduates in temporary and permanent positions with good chances for promotion.

458. The Chief Engineer, American Well Works, Aurora, Ill., wants draftsmen.

459. Material Superintendent wanted before October 1, by Chicago machinery manufacturer, at an initial salary of $200 per month. He will be responsible for all factory functions except: maintenance of equipment, training hands, tool designing, process inspection. He will be immediate subordinate of works manager, and will have to compete with one man for advancement. Describe education and physical condition in detail. State exact nature of duties and number of months spent in each capacity, and name firms. Address: S. Montgomery, Riverside, Ill.

460. Mr. E. P. Waud, '05, Griffin Car Wheel Company, McCormick Building, Chicago (chilled iron card wheels) has openings for several young men, not necessarily graduates. The men would be given training for two or three years in the various departments with view to advancement to responsible positions later.

461. Mr. H. Collan, manager Compressor and Engine Plant, Chicago Pneumatic Tool Company, Franklin, Pa., has opportunities for factory executives, mechanical engineers, salesmen, sales engineers and the like.

462. Mr. A. T. Smith, The R. U. V. Company, 50 Broad Street, New York City, wants shop superintendent to take complete charge of fabricating, testing and designing Ultra Violet Ray Sterilizers, which entails knowledge of machine shop work and electricity. Prefer man somewhat advanced in years who has held an equivalent position.

463. Mr. J. S. Young, vice-president, J. S. Young Company, Baltimore, Md., wants mechanical engineer 30 to 40 years of age to supervise engine and boiler equipment, machinery for making extracts (licorice, tanning and coloring, etc.) and to aid in planning new plant and equipment. Wants man to develop for special business with good future.

464. Mr. G. R. Norton, Sizer Forge Company, Buffalo, N. Y., wants man experienced in tool equipment and shop practice, to install Taylor System of Scientific Management under direction of consulting engineer. Man need not be familiar with Taylor System. Work to cover not less than three years and lead to good permanent position.

465. Mr. C. W. Van Law, '90, second vice-president of operations, U. S. Smelting, Refining and Mining Company, 55 Congress Street, Boston, Mass., wants two graduates of from two to five years. One man wanted in Colorado in permanent mining and metallurgical development with large plant now under erection. Man to take charge of mechanical and electrical operations after being on job during construction period. Second man for large coal mining operation in Utah, with large amount of electrical mining, machinery, electric locomotives, etc. Man to develop for important position.

*467. One of the largest manufacturers of steel automobile parts wants metallurgist familiar with chemical and metallographical control. Must have initiative to lay out proper methods and personality to see that they are followed.

468. Mr. C. S. Roberts, president Wahl Adding Machine Company, 232 E. Ohio Street, Chicago, wants several recent graduates. "We have a splendid place for such young men."

469. Mr. Edwin N. Trump, Solvay Process Company, Syracuse, N. Y., wants recent graduates; also men of three or more years experience.

471. Mr. Joseph Zimmerman, Goodyear Tire and Rubber Company, Akron, O., has good openings for recent graduates.

472. Mr. E. M. Lines, superintendent The Barber Asphalt Paving Company, Maurer, N. J., wants combustion engineer for efficiency work connected with power plants.

473. Mr. C. W. Gillespie, Eastern, Pa. Railway Company, Pottsville, Pa., wants electrical engineering graduate at $80 to $90 per month, depending on qualifications. Opportunity for advancement.

474. Mr. M. J. Rich, Empire Rubber and Tire Company, Trenton, N. J., wants two draftsmen. Wants men interested in taking up engineering work connected with manufacture of rubber goods.

475. Mr. Thos. C. Desmond, T. C. Desmond & Company, 110 W. 34th Street, New York City, wants young mechanical engineer as general mechanical assistant in steel ship building plant at Newburgh, N. Y., and also to do general mechanical drafting. New yard with good opportunity for rapid advancement. Prefer man with about one year's experience.

478. Mr. H. B. Bernard, gasoline department, Sinclair Oil & Gas Company, Tulsa, Okla., wants recent graduates for construction, operation and experimental plant work. Concern subsidiary to largest independent oil company; gasoline department recently organized and developing.

479. Mr. E. Mallinckrodt, Mallinckrodt Chemical Works, St. Louis, Mo., wants recent graduate as assistant in mechanical department for maintenance and developing of equipment. Good opportunity for advancement. Westerner preferred.

480. Prof. Geo. R. McDermott, care Emergency Fleet Corpn., Munsey Bldg., Washington, D. C., wants to place Cornell men in shipyards where there is very urgent need for men on government work.

481. Graduates of courses in industrial and business management, or similar courses, are eligible for commission in Quartermaster Officers' Reserve Corps. Address Quartermaster General, War Dpeartment, Washington, D. C.

482. Commanding Officer, Sandy Hook Proving Ground, Fort Hancock, N. J., wants recent graduates as draftsmen ($1000 to $1200) with opportunity to qualify for permanent appointments. Men are urgently needed.

483. E. E. Kiger, '98, steam engineer, Lackawanna Steel Company, Buffalo, N. Y., wants recent graduate for general testing and experimenting, especially in connection with boiler and gas-producer work. Also summer openings.

484. Mr. R. D. Kehor, president, Hercules Engineering Corporation, 501 Fifth Ave., New York City, has opening for graduates or undergraduates. (Chemical plants, refrigeration, water purifying, etc.)

*Send applications to this number care of Sibley Employment Bureau for forwarding.

ENGINEERING ABSTRACTS

Abstractors: Prof. Barnard, Prof. Gray, Prof. McDermott, Prof. Diederichs, Prof. Albert, Prof. Wells, Prof. Ellenwood, Asst. Prof. Upton, Asst. Prof. Sawdon, Asst. Prof. Gage, Asst. Prof. Hayes, Asst. Prof. Ham, Asst. Prof. Peirce, Asst. Prof. Garrett, Asst. Prof. Berry, Asst. Prof. Lee, Asst. Prof. Pertsch, H. W. Brown, F. G. Tappan, F. L. Fairbanks.

The Sibley Journal will mail the magazines containing the articles abstracted to its subscribers at cost price.

Diesel Engine Plants, by M. William Ehrlich in the *National Engineer* for March, 1917.

The most important feature of any power plant is the system of piping. In the oil engine plant this is not so large as in a boiler plant of equal capacity, but more lines may be necessary.

Internal combustion engines do not produce their full rating at high elevations, due to the reduced density of the atmosphere. (A table of values is given.)

There follows a description of a plant containing two 500 horsepower Diesel engines, built by the McIntosh & Seymour Corporation, of Auburn, N. Y., direct connected to 300 K. V. A. alternators. There are two 10,000 gallon oil storage tanks, and a pump house about 100 feet from the power plant. In the engine room there is a 500 gallon tank for each engine, mounted 15 feet above the floor. A small tank contains kerosene which is used for starting the engine when cold. The fuel oil is purified and heated before reaching the fuel valves.

Connected with this plant is a 50 ton refrigerating and ice-making equipment. The water supply for the combined system is from two independent sources. The water system is piped and valved so that almost any combination can be secured. For example, the water leaving the ammonia condenser may be passed through the engine cylinder jackets, then delivered to the dip tank for thawing blocks of ice out of the cans, and from there taken to a spray cooling pond. In this way great economy is affected in the consumption of water.

The construction of trenches for underground piping is discussed briefly. C. H. B.

Structure of the Atom, by Dr. Saul Dushman, Research Laboratory, General Electric Company, *G. F. Review*, March and May, 1917.

In these two papers, Dr. Dushman discusses the theories of the structure of the atom in the light of the most recent discoveries in physics. Any theory of the structure of the atom must still be only an approximation, but of some things we are practically certain.

First: The atom consists of a positive nucleus of extremely small dimensions (10^{-13} cms. dia.), but approximately equal in mass to the atom itself, and of a number of electrons distributed perhaps in one or more rings or spherical shells outside the nucleus, the total number of electrons being equal to the positive charge on the nucleus.

Second: All the physical and chemical properties of the atom (excepting radioactive and gravitational) are governed solely by the magnitude of this charge on the nucleus (or atomic number).

Third: In order to explain chemical combination and periodic properties, we must assume that there are two classes of electrons, an inner and an outer set. The outer ones are active in chemical combination and conduction of electricity in metals. They are the so-called valency electrons. They are very sensitive to changes in condition, such as temperature, pressure, and the presence of other atoms. The number of electrons in this outer set undergoes periodic changes in value as the atomic charge increases, and the maximum number of electrons which are stable on the outer surface of the atom is eight, thus accounting for the periodicity of eight in Mendeljeff's table.

The inner set of electrons are unaffected by ordinary methods, but high velocity electrons may stimulate them and thus produce the high-frequency spectra observed by various experimenters.

Ordinarily, the positive and negative constituents of a compound are held together through the medium of the electron. Under certain conditions, however, the electrostatic force acting between the metallic atom and its electron becomes so weakened that the negative constituent escapes carrying the electron with it. Physicists are generally agreed that chemical combinations between different atoms consists in the transference of one of the outer electrons from one atom to the other. But as to the actual distribution of the electrons in the different atoms and the nature of the forces between the electrons and the positive nucleus there is a quite a variation of opinion.

Dr. Dushman then discusses the theories of the atomic structure advanced by Thomson, Seins, Bohr, Hull and others:

"Besides the problem of the configuration of electrons in the atom, there remains the even more difficult question of the structure of the nucleus itself. From the fact that radioactive elements emit both alpha particles and electrons, we know that the nucleus itself must be an exceedingly complex aggregation of positive and negative charges. When the atom of uranium disintegrates, it emits eight alpha particles

before it reaches the end of its disintegration and becomes an atom of lead. All these particles must have come from the nucleus. It is evident that the forces which can hold at least eight posivitely charged helium atoms in a volume which is extremely small compared with that of the uranium atom itself—that these forces must be of an altogether different nature to any with which we are familiar in ordinary mechanics. Furthermore, what law governs the time at which any atom shall spontaneously explode and emit these alpha particles? A. Dieberne, who has done a great deal of work on the radioactive elements, believes that the structure of the nucleus is exceedingly complex, that the constituents of the nucleus are in a constant state of agitation, in which respect they resemble the molecules in a given volume of gas, and that following the law of probability, one of these constituents of the nucleus may at some instant acquire enough kinetic energy to carry it out beyond the confines of the nucleus and of the atom itself.

"W. D. Harkins and E. D. Wilson have put forward the rather interesting suggestion that the atoms of all the elements are made up of hydrogen and helium. They show that the deviations from whole numbers observed in the atomic weights can be ascribed to a packing effect which must occur if the other atoms are built up of hydrogen atoms. This means then, that the nucleus contains both hydrogen and helium nuclei in varying proportions.

"The deeper we penetrate into the question of atomic structure, the greater the vista of problems that apparently opens before us. Is it an infinite series? Only the future can tell; but if past experience teaches us any lessons at all it is perhaps this: that the problems of science can never end, for that would mean an end of all human striving and existence itself."

A good bibliography of the subject is appended to the May article. F. G. T.

The Steam Motor Car, by Abner Dobel in the *Journal of the American Society of Mechanical Engineers* for April, 1917.

This is an interesting article written by the man who has recently brought out a very satisfactory car having several novelties. He begins the article by a discussion of the unsatisfactory points of the older types of steam cars which were, briefly, the low mileage on a given amount of water, the scale in the boiler and the trouble involved in the burner. He then discusses some of the results of his experiences regarding the use of oil in a boiler and the following quotation is perhaps the best way to present this to the readers of this abstract.

"As far as I could find out, the use of a very heavy oil, especially where superheated steam was not employed, was a superstition. The presence of moisture in the steam goes a long way toward the proper lubrication of the cylinders and valves. In a steam-motor car little lubrication is required, as the piston speed is low at ordinary driving speeds, and the cylinder surface is cast iron, which is easy to lubricate.

"In view of the foregoing it was determined to try ordinary gas-engine cylinder oil, and from the first it proved entirely satisfactory. To eliminate the possibility of melting solder in the radiator, we chose a fire-tube boiler. We realized that the presence of oil in the boiler would cause violent foaming, but believed that the high pressure would eliminate trouble from this source. The normal steam pressure in the boiler was 600 pounds, but as soon as the steam passed the throttle valve there was a large drop in pressure, sufficient to cause any water coming over from the boiler to pass into steam immediately.

"Another reason why we did not use the customary heavy oil was because of the effect it would be certain to have upon the boiler. The action of the thin oil was all that could be desired. It immediately went into an intimate mixture with the water, due to the violent agitation and intimate contact. . . . This oil is very thin at 420 degrees F., the approximate steam temperature at 600 pounds pressure, and the coating of oil, which forms over the entire inner surface of the boiler, is consequently so thin as to have a negligible effect upon the heat-transference conditions, and does not materially increase the liability of burning the heating surface."

"As scale cannot adhere to a surface coated with oil, the interior of the boiler remains entirely free from incrustations of scale matter, and is likewise quite thoroughly protected from corrosion. The second function of the oil is to coat each particle of scale-forming material as it is thrown out of solution, thus preventing one particle from sticking to another in such a way as to form a body of sufficient size to clog some restricted passage."

"I have carefully examined the boiler and radiator of a car driven over forty thousand miles, and they were as clean or cleaner than when the car was built. I do not believe that there could be a more adequate proof of the entire effectiveness of the system. Lastly, the oil performs its normal function, being carried along with the steam in the form of minute globules, thus lubricating the throttle valve, cylinder walls and inlet valves."

The next discussion is that relating to his steam generator which was finally built to consist of a number of identical sections of steel tubing with upper and lower header and sixteen vertical tubes. This generator is designed for working pressure of 600 pounds to the square inch. The combustion system is next and the most important development in this connection was the idea to use a spark plug for ignition, a carburetor for mixing the fuel and air, and an electrically driven blower to supply the forced draft. Regarding the use of coal kerosene for fuel, the following remarks are made:

"1. The kerosene had to be broken up mechanically into sufficiently small particles to insure a rise in

temperature past the point of ignition during the time in which they absorbed heat from the spark.

2. The spark had to occur close to the atomizing nozzle at a point where the resultant fog was sufficiently dense to insure one group of kerosene particles invariably igniting the rest.

3. The velocity of the fuel particles had to be low enough to permit them to absorb sufficient heat from the spark to raise their temperature beyond the ignition point.

4. It was essential that the mixture be much richer in the vicinity of the electric spark than that which would provide the most efficient combustion. In the latter connection we also found that in order to secure complete combustion of a large amount of fuel in a small space, it was necessary to utilize a combustion chamber made of a highly refractory material designed to attain a very high temperature."

For the engine he decided to use a simple engine of the uniflow principle for the reason that he believed it to be the most economical, simplest, and the most nearly noiseless. He closes the article with a summary of the principal advantages claimed for such a steam power plant as follows:

"1. Torque range of 100 percent with a maximum torque available at zero speed; change-gear mechanisms and clutch therefore necessary.

2. Mean effective pressure (and equivalent drawbar pull) always under control of the operator; variable by throttle and cut-off from zero to maximum, a maximum limited only by the tractive capacity of the rear wheels.

3. Utmost mechanical simplicity with not over twenty-four moving parts in the entire car and only eleven in the engine.

4. Smooth and quiet operation, due to low engine speed and to location of the engine.

5. Low manufacturing cost, owing to simplicity of construction and lack of "fussy" work in production.

6. Entire absence of lubrication troubles; no contamination of crankcase oil by kerosene, gasoline, water, road dust, or carbon.

7. Low fuel cost per mile. F. O. E.

BOOK REVIEWS

Lettering, for Draftsmen, Engineers and Students, by Chas. W. Reinhardt. A practical system of free-hand lettering for working drawings. Fourteenth edition revised and enlarged. Forty-fifth thousand. 39 pages, 15 plates. 1917. Price $1.00. D. Van Nostrand Co., New York.

This is the latest edition of the well-known Reinhardt treatise on lettering. The fact that the book has retained its popularity among draftsmen and engineers since its first issue more than twenty years ago, is proof of the practical usefulness of the system of lettering which the author advocates.

The system outlined is the result of the author's experience during years of practice on the staff of one of the leading technical journals and is intended to set forth the proper methods of forming purely free-hand lettering in a simple, easily acquired way, giving, at the same time, the proper safeguards against the errors most commonly committed.

A characteristic of the book is that no attempt has been made to initiate any special form of printed alphabet, and all ornate or elaborate lettering, which is barely of use to the draftsman, has been omitted. The lettering illustrated has been reproduced without any attempt at touching up or cleaning; it is actual free-hand work such as would be used in general practice.

The subject of lettering as applied to working drawings and the construction of titles, has been taken up in detail, and an interesting and useful chapter is devoted to lettering for purposes of photo-reproduction.

The additional material in this latest edition consists in the supplementing of various chapters, the compiling of the analyzed Greek alphabet, plates containing various methods of laying out and constructing titles, and numerous practice sheets. This gives the book a more rounded aspect and will undoubtedly increase its usefulness. This little treatise is freely illustrated, and contains fifteen full page plates of unusual merit.

C. W. H.

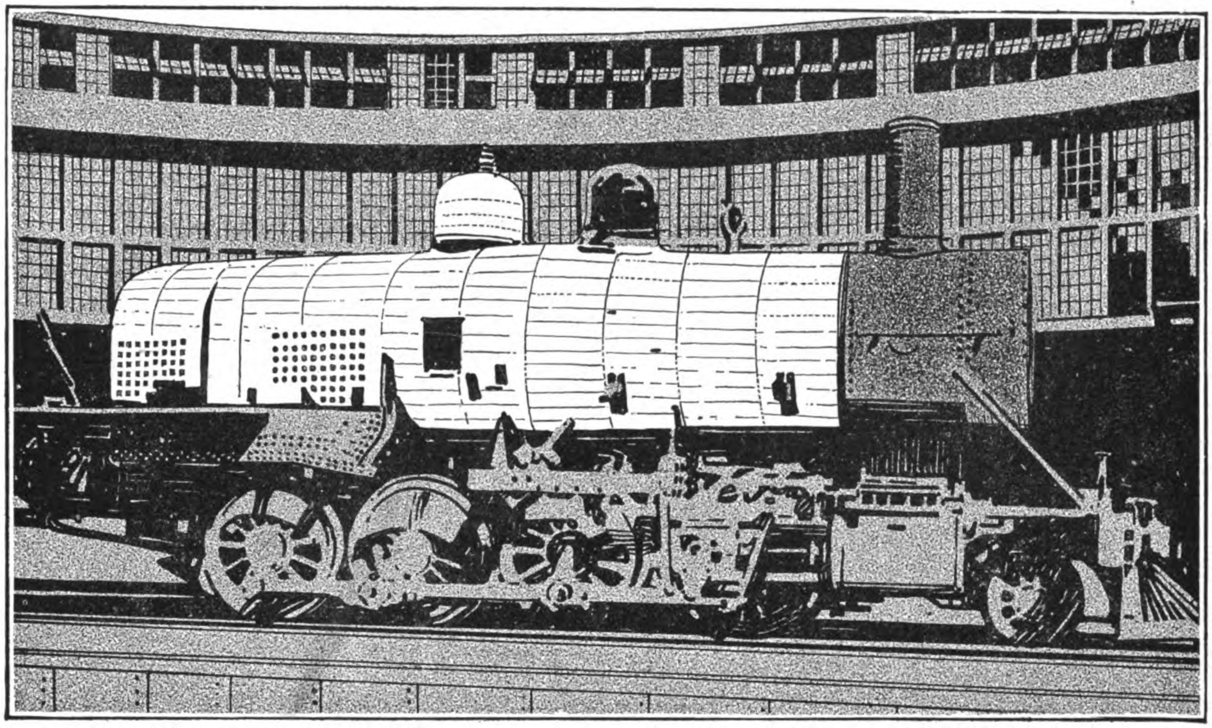
Gasoline. A Hand Book by G. A. Burrell, formerly of the Bureau of Mines. Published by the Oil Statistical Society, Inc., of Boston, Mass.

This 4½ x 6 inch 281 page flexible covered book, well printed and bound, aims to give useful information of a scientific sort to all interested in gasoline.

A brief tabulation of the section headings would in no way indicate the true excellence of the writer's skill in describing complicated processes and imparting unusual information in a simple straightforward manner.

The book is not divided into chapters and has no index. The general arrangement of the material seems somewhat unfortunate. However, the first 20 pages deals with the precautions necessary in the handling of gasoline, giving explosibility range, methods of extinguishing gasoline fires, the detection of presence of gasoline vapor, etc., a portion of the book which should interest all users of gasoline. Then follows a brief history of the motor vehicle in this country with a description of some of its parts, paying particular attention to the carbureter, its types and its use. Thirteen pages are now devoted to instructions to automobile drivers incidently explaining how fuel may be economically used under various conditions. A very useful section on engine troubles and remedies together with the composition of non-freezing mixtures to be used in water jackets is next included. Tractors and aeroplanes are very briefly touched upon; their importance in the present war being considered. The necessary

(*Continued on page 8 ad.*)



BOOK REVIEWS

(*Continued from page 240*)

requirements for a good lubricating oil, a brief description of the various tests and a lubrication schedule for an automobile seems to conclude the material dealing with the use of gasoline in the internal combustion engine.

The use of gasoline as a cleaning fluid is now considered, and the general process which is followed in the ordinary cleaning establishment is briefly described. Gasoline is also used as a solvent in the paint and rubber industries. The grades of the distillate best adapted to this work are indicated.

The next section deals with the history of crude oil, the classification of the oil fields, the composition of the oil from the various fields and a rather complete description of the methods of refinement. Various charts and tables, many of them the work of the author while in the Bureau of Mines, tend toward the compactness of this portion of the book. "Cracking" processes including the Burton and Rittman methods are briefly explained as well as the methods of obtaining gasoline from natural gas.

Kerosene, alcohol, benzol and naphthalene are considered as possible substitutes for gasoline as a motor fuel, the objections to each being given.

A few very useful tables of chemical and physical properties of the principal constituents of gasoline as well as some of the more ordinary table of measurement, etc., precede the closing section. This last 40 pages is devoted to the nomenclature of all the different parts of the automobile. Perhaps a few sketches could have been used to advantage in this section to add to the clearness or completeness of the text.

The book was not written primarily for engineers or engineering students, but much of the material will be found helpful to them because it gives information which is very difficult to find elsewhere. C. A. P.

MOTION-PICTURE DEVICE

(*Continued from page 234*)

In this case, the image was restricted to a narrow band by inserting a one millimeter slit in front of the box in which the moving film is inclosed. This is done in recording shutter speeds of one-tenth, one-fifth and one-half second, because the three feet of film mounted on the rim of the wheel only takes about fifty shutter images without serious lapping. To facilitate counting of these images one mirror is painted black, thereby causing a blank to appear at every twentieth exposure as shown. Fig. 4 shows exposures taken with a focal-plane shutter with a short-time opening and Fig. 5 with a long-time opening. By drawing a straight line at right angles to the slit images shown in Fig. 4 the number of points at which the line is cut by the slits determines the extreme number of thousandths of a second the slit of the shutter is passing across a given point on the plate. In this case the line intersects eight slit images and therefore the total exposure is eight one-thousandths second.

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY ITHACA, N. Y.

Vol. XXXI SEPTEMBER, 1917 No. 12

THE SIBLEY JOURNAL OF ENGINEERING

SIBLEY COLLEGE, CORNELL UNIVERSITY

Editor—J. C. FRIEDRICH

Published by

THE SIBLEY JOURNAL OF ENGINEERING, INC.

ITHACA, N. Y.

Founded 1885 *Incorporated* 1916

JUSTIN F. WAIT, President
WILLIAM N. BARNARD, Vice-President
EARL G. HENDERSON, Secretary-Treasurer
CLARENCE A. PEIRCE, Second Vice-President

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year
Foreign, $2.25 a year, payable in advance

Remit by postoffice or express money orders, bank checks made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

CONTENTS FOR SEPTEMBER, 1917

The 1917–18 Outlook

With the streams of young manhood flowing into the conscription cantonments this fall, there remains a great uncertainty of how the University's courses will shape themselves. At this time our interest is more or less focussed on what the Universities will do during the coming year. And, especially are we interested in the prospects of Sibley College.

Last year Sibley started out with the large enrollment of 919. This year about 600 are expected to take up the mechanical engineering course; but, of this number there is no surety. The following excerpt from Dean Smith's report to President Schurman may help us.

"This revision" (Dean Smith here refers to the reduced attendance for the coming year) "required a considerable reduction in the faculty but this reduction has occurred automatically by the temporary or permanent withdrawal of faculty members to undertake Government work. . . .

"The changes of the faculty from the February to the June budget, because of reduction and rearrangement, are as follows:

Number of professors reduced from	13 to 9
Number of assistant professors increased from	13 to 15
Number of 2 year instructors reduced from	16 to 11
Number of 1 year instructors reduced from	35 to 24
Number of assistants reduced from	3 to 2
Total reduction	80 to 61

This corresponds to a reduction in the total number of nearly 23 per cent. The ratio of what may be called the permanent faculty—the first three classes given above—to the total is, for the February budget, 51.9 per cent; while for the June budget the same ratio is 57.4 per cent. Upon the same basis this ratio for the current year is 53.2 per cent. This shows that the changes have increased the proportion of experienced teachers in the faculty.

"Moreover, the number of students per teacher during the current year (before the exodus*) was about eleven, while for the next year, according to the June budget and the estimate of attendance, the students per teacher will be about ten.

"With increased proportion of experienced teachers and reduced number of students per teacher, the quality of instruction should rise; at any rate, Sibley College will be in at least as good a condition for effective teaching next year as ever before."

*356 Sibley students left the University between April 6 and June 16 to take up some form of service for the Government.

THE NEEDS OF THE ENGINEERING SCHOOLS AT CORNELL

JACOB GOULD SCHURMAN, A.B., A.M., D.Sc., LL.D.*

It is impossible to exaggerate the importance of the functions of the engineer in the modern world. Nearly all of the material constituents of modern civilization and a large part of the economic are the work of his hands. His first great achievement was the construction and operation of railroads and steamships; later he revolutionized productive industry by applying science to the extractive and manufacturing arts; he now co-operates with the architect in rearing the mammoth structures of modern cities; he provides for these cities, light, heat, and water, and disposes of their sewage; he has established instantaneous communication between all parts of the world by means of both submarine and aerial messengers; and, in general, he has determined the character and he maintains the control of nearly all the productive activities of the modern world, satisfying the needs of men, ministering to their convenience and comfort, and holding out to them with the progress of scientific knowledge the prospect of indefinite improvement in the conditions of existence and in the means of happiness and advancement towards greater perfection.

When one reflects on these functions of the engineer it seems surprising that the recognition of the vocation by our universities and institutions of higher learning has been so recent. Cornell University is less than half a century old, yet Cornell was one of the first to recognize engineering. And the schools of engineering at Cornell have brought great distinction on the University, as they have won for themselves a place in the educational history of the country. Ezra Cornell's conception of a university where any person could find instruction in any study grew out of a consciousness and conviction that a modern university, without, indeed, surrendering its devotion to ancient ideals, must also deliberately serve the industrial interests of the country and apply to their support and development the facts and principles established by investigators in the field of pure science. This is a common-place matter to-day, but when Ezra Cornell conceived it half a century ago it was a new and revolutionary idea. And it is this more than anything else which has made Cornell University a pioneer of the New Education.

No university, however, can repose on the laurels it has won. It must ever be pressing forward and conquering new fields. And the time has arrived for a fresh development of the engineering schools of Cornell University. If we consider for a little while the definite objects of an engineering school we shall soon realize what improvements are needed at Cornell.

In the first place, engineering is applied science. Consequently, there can be no engineering unless there is science to apply, nor any progress in engineering unless there be advancement in pure science. But if science is to be advanced and enlarged to furnish a foundation and a principle of growth for engineering it can only be by means of the investigations conducted by able and well-trained minds who give their supreme energy to that object. It follows accordingly that the endowment of professorships devoted to research is a fundamental requisite in a great modern school of engineering. I would not, indeed, generally speaking, relieve research professors of the obligation of giving instruction to undergraduates: such work is good for them and good for the undergraduates. But as Lord Kelvin said to me on his visit to Cornell University some years ago we make the mistake in America of overloading our professors with teaching, so that, when they come to research, their minds are already jaded and exhausted. Men who have the unusual ability or genius requisite for successful research should not have more than four or five hours a week of teaching. But I repeat that some teaching is good for them. When I was a student in Berlin University the most productive scientists and scholars were men like Helmholtz, Du Bois-Reymond, Mommsen, and Zeller, all of whom I had the honor of knowing personally. And while they were producing original works which commanded the admiration of scientists or scholars the world over they at the same time gave courses of instruction even in beginning classes to students in Berlin University.

Secondly, besides discoveries of new facts and principles of science it is essential in an engineering school that these should be applied to industrial processes and operations. The good engineering school is one which represents science in its highest stages of development and which reflects or reports the manifold organization of the industrial world with its best and latest improvements. Its professors must be masters of the sciences and also conversant with all the practical developments in the constantly changing industrial world.

Thirdly, the investigators and teachers in a good engineering school must have modern and commodious laboratories, well equipped with scientific apparatus, with shops stocked with modern machinery, and with models, charts, and similar illustrative material. If the first essential of a school of engineering is first-class experts, scientists, and engineers—the next requisite is the instrumentalities of which they make use in research and instruction, namely, buildings, machinery, and all kinds of apparatus.

In every one of the directions just indicated, the engineering schools at Cornell University are now in need of a new expansion and development. Thanks to the recent gift of Mr. Hiram W. Sibley of Rochester the

*President of Cornell University.

apparatus and equipment in Sibley College has been brought pretty well up to the modern standard of requirement, though in all departments of engineering the professors are requesting new apparatus and facilities which can not be furnished for lack of funds. Still greater is the need of new buildings. Lincoln Hall and Franklin Hall, which are old, unfinished, and entirely unsuited to their present uses, should be replaced by new, commodious, and larger buildings devoted respectively to Civil Engineering and Electrical Engineering. And, although the late Hiram Sibley of Rochester, and his son, Hiram W. Sibley, as well as Mrs. Florence Osgood Rand Lang of Montclair, N. J., have donated valuable buildings for the purposes of Mechanical Engineering, the accommodations are still wholly inadequate. Plans were made some years ago for two new shop and laboratory buildings to replace the old shop buildings north of Sibley College. And the need of these proposed buildings increases with the lapse of every year.

But the greatest need of all, both in the Sibley College of Mechanical Engineering, and in the College of Civil Engineering, as also in the Department of Electrical Engineering, is of teachers and investigators of first-class ability, thorough scientific training, and (whenever possible) of practical experience also. We have indeed among our engineering professors some of the ablest and most effective men in the profession. But too large a proportion of the instructing staff in our schools of engineering is made up of instructors, and too small a proportion of professors. This arrangement has been due to a practical necessity: it was the only way to provide an adequate number of teachers for the increasing number of students. We can not, however, shut our eyes to the fact that the financial limitations of the University are a menace to the highest educational ideals. In other words, the great and flagrant need in the engineering schools of Cornell University is of endowments for professorships in the various branches of engineering science and practice. Although business men have made fortunes in the industrial world from the services of engineers and the use of engineering science, the one professorship endowed by the late Hiram Sibley is the only one that has ever been endowed in an engineering school at Cornell.

The time has arrived when millions of dollars are needed to bring the Cornell engineering schools up to the level of the requirements of the new age on which we are now entering. And of these millions of dollars the larger portion should be devoted to securing and maintaining eminent experts for the work of teaching and research in engineering.

I can not too strongly impress upon the friends of Cornell and upon philanthropists generally who are interested in education, especially in practical education the importance of providing proper salaries for professors. Lest my plea be thought sensational or unreasonable let me quote from the first page of the third of the series of booklets recently issued by the Harvard Endowment Fund Committee. Here is what that Committee states about salaries at Harvard:

"1. The last increase in the College salary scale was made in 1906.

2. Rising prices have driven down the purchasing power of a given salary 44% since 1908.

3. Harvard has, therefore, not only been unable to increase the salary for a given service to-day over what it paid for the same service eleven years ago, but owing to rising prices, is really paying 44% less than in 1908.

4. Industrial wages throughout the country have increased to counteract almost entirely the rising cost of commodities.

5. Although Harvard still leads Yale and Princeton in the salaries paid its full professors, several colleges are now paying more than Harvard's maximum of $5,500.

6. Harvard College salaries should be increased at once, both to counteract the rising cost of living and to insure, as in the past, the presence in the Faculty of the best minds obtainable."

The facts here set forth are as true of Cornell salaries as of Harvard salaries, and they press more heavily on Cornell teachers than on Harvard teachers, because all salaries are lower at Cornell. Whereas the Harvard maximum salary for full professors is $5,500, the Cornell maximum salary for full professors is $4,000. And there is a corresponding difference between the salaries of assistant professors and instructors at the two institutions. It means, therefore, more for a Cornell teacher than for a Harvard teacher to be told that if he is wholly dependent on his salary, as nearly all Cornell teachers are, his income is 44% poorer in purchasing power to-day than it was in 1908. The general wage earner has fared very much better. In spite of rising prices, wage earners, if paid in commodities, would receive about the same amount of goods to-day as in 1908. In other words, wages have nearly kept pace with the rising cost of commodities. But, confronted by that same scale of rising prices, the professor is 44% poorer.

Some universities have recognized this situation by advancing the salaries of professors. Even the state universities of the west, which have nearly always paid low salaries, are now beginning to raise salaries in the competition for first-class men as professors. The University of Illinois is known to have offered $5,000 and even $6,000 to men whom it was anxious to obtain. And the figure of $5,000 has been adopted in more than one state university.

As I have intimated already, the proper way of dealing with the question of the development of the engineering schools at Cornell is the provision of a large endowment, say $5,000,000, to be set aside for the exclusive use of these schools. The income of such an endowment would enable the University to establish a suitable number of professorships, to provide adequate salaries for the professors, assistant professors, and instructors, and to purchase the necessary apparatus and equipment. I would not use a cent, either of the principal or income, for buildings. Under the supposi-

(*Continued on page 300*)

ALPHABETICAL LIST OF FORMER STUDENTS OF SIBLEY COLLEGE

ABARCA, HENRY, '09. 2 Puntilla St. San Juan, P. R.

ABBEY, SAMUEL HAMILL, '09. (1)* 211 Seward Pl., Schenectady, N. Y. (2)and(3) General Elec. Co.

ABBEY, FRANK HUMPHREY, M.E., '01. Boston Mgr. Gifford-Wood Co. (1) 1822 Beason St., Brookline, Mass. (2) and (3) 51 North Market St., Boston, Mass. A. S. M. E., A. I. E. E.

ABBOTT, CLINTON SETH, '12. Coke Oven Operator, H. Koppers Co. H. Koppers Co., Pittsburg, Pa. Hamburg, N. Y. (3) H. Koppers Co., Pittsburgh, Pa.

ABBOTT, FRANK F., '14. Manf'g Methods, Western Elec. Co. Care Western Elec. Co., Dept. 1482. (2) and (3) 711 W. Gray St., Elmira, N. Y. (1) 2622 S. 60th Ave., Cicero, Ill.

ABBOTT, JOHN, '00. Sheffield, Ala.

ACHESON, ARTHUR MURRAY, '14. 37 Madison Ave., New York City. Ardsley-on-Hudson.

ACKART, EVERETT GUNNER, M.E., '05. Power Engr. (2) and (3) Dupont Bldg., Wilmington, Del. (1) 1405 Rodney St., Wilmington, Del.

ACKER, ERNEST REYNOLDS, M.E., '17. 8 Main St., Ossining, N. Y. Tau Beta Pi.

ACKER, MILTON, M.E., '13. Mgr. Connecticut Branch, National Workmen's Compensation Service Bureau. (1) 2310 7th Avenue, New York, N. Y. (2) 18 Asylum St., Hartford, Conn. (3) 68 Buckingham St., Hartford, Conn. Natl. Safety Council.

ACKER, WILLIAM LEWIS A., M.E., '05. (3) Box 446, Scranton, Pa. (1) 1206 Vine St., Scranton, Pa.

ACKERLEY, RAYMOND SLAUGHTER, '11. Crystal Run, Orange Co., N. Y.

ACKERMAN, ALBERT M., M.E., '16. 3170 Curlew St., San Diego, Cal.

ACKERMAN, A. M. Combustion Eng. Corp., 11 Broadway, New York City.

ACKERMAN, JOHN WALTER, M.E., '97. Chief Eng. & Supt. Auburn Water Works. (2)and(3) 7 Exchange St., Auburn, N. Y. (1) 26 Nelson St., Auburn, N. Y. A. S. M. E., A. S. C. E., Am. W. W. Ass., N. E. W. W. Ass., A. Pub. H. Ass.

ACKLIN, JAMES MONTGOMERY, M.E., '06. (2) and (3) (Bus.) V.-Pres. and Manager Acklin Stamping Co., Toledo, O. (1) 2518 Glenwood Ave., Toledo, O.

ADAIR, CRAIG, '06. 402 W. 20 St., Wilmington, Del. Penn. Seaboard Steel Corp., Philadelphia, Pa.

ADAM, FOLGER, '04. (1) 208 Sherman St., Joliet, Ill. (2) and (3) R. R. and Crogham Sts., Joliet, Ill.

ADAM, ROBERT, '89. Joliet, Ill.

ADAMS, ALTON D., '84. Public Service Engineer. (2) and (3) 15 Beacon St., Boston, Mass. (1) Natick, Mass.

ADAMS, CLARENCE SMITH, M.E., '04. Copper Queen Cons. Min. Co., Douglas, Ariz.

ADAMS, CUYLER CULVER, M.E., '05. Supt. Brevanago Mining Co., Deerwood, Minn.

ADAMS, EDWARD THOMAS, M.E., '94, M.M.E., '96. Allis-Chalmers Co., Milwaukee, Wis.

ADAMS, FRANKLIN ALEXANDER, '14. Maple Hill, Kansas.

ADAMS, FRANCIS SPEARMAN, M.E., '05. (1) and (3) 7 Pitkin Ave., Pueblo, Col.

ADAMS, GUY PORTER, '15. 109 Oneida St., Utica, N. Y.

ADAMS, HENRY JEWETT, M.E., '10. 4992 Stuart St., Denver, Colo.

ADAMS, JOHN HACKETT, '98. 6801 14 Ave. N. E., Seattle, Wash.

ADAMS, THOMAS DICKINSON, '05. Care Foundation Co., 115 Broadway, New York City.

ADAMS, WILLIAM HUNTINGTON, '09. (2) and (3) 1170 Broadway, care U. S. Gypsum Co., New York City. (1) 1225 15 St., N. W. Washington, D.C.

ADDICKS, FRANK FLORIS, M.E., '13. Engr. Asst., New York Tel. Co. (2) and (3) 16 Dey St., New York City. (1) 1793 Montgomery Ave., Bronx, New York City. Telephone Soc. of N. Y.

ADDICKS, WALTER ERNEST, M.E., '14. Mech. Engr. Cutler Hammer Mfg. Co. Care Cutler Hammer Mfg. Co. (2) 144th St. & So. Blvd., New York City. (1) and (3) 1339 University Ave., New York City.

ADENFORF, JOHN, M.E., '07. Box 1613, Johannesburg, S. Africa.

ADLER, EMIL, M.E., '09. 1000 Broadway, Buffalo, N. Y.

ADYE, ELTON MERVILLE, '07. Forestville, N. Y.

AGUILERA, ANTONIO BERNABE, M.E., '15. (2) and (3) Prado 6, Havana, Cuba. (1) Cential Senado, Camaguey, Cuba.

AGUIRRE, JOSÉ URBANO, M.E., '10. 572, 9 de Julio St., Santa Fe, Arg. Rep., S. A.

AHBE, FREDERIC R., M.E., '07. (1-2-3) 615 S. Main St., Athens, Pa. M. A. I. M. E., and Western Soc. of Engineers.

AHERN, THOMAS FRANCIS, M.E., '94. Mgr. Modern Mach. & Eng. Co., 1514 Ford Bldg., Detroit, Mich.

AIME, FRANK LOUIS, M.E., '11. (2) 435 6th Ave., Pittsburgh, Pa. (1) Perry, N. Y. (3) 6205 Alden St., Pittsburgh, Pa. A. I. E. E.

AITKEN, JOHN WINFIELD, JR., '08. 41 Garfield Ave., Carbondale, Pa.

ALBERGER, ALVAN HYDE, M.E., '93. 665 W. Ferry St., Buffalo, N. Y.

ALBERT, CALVIN DODGE, '02. Prof. Machine Design. (2) Sib. College, Ithaca, N. Y. (1) and (3) 2 Reservoir Ave., Ithaca, N. Y. Sigma Xi, A. S. M. E.

ALBREE, FREDERICK WILLIAM, '91. (2) and (3) 125 Prince St., W. Newton, Mass. (1) Home: 191 Ridge Ave., Allegheny, Pa.

ALCACER ISMAEL SATURNO, '14. 925 Rio Bamba, Buenos Aires, Arg. Republic, S. A.

ALCOCK, HARRY HILL, '96. (2) and (3) 96 Wall St., New York City. (1) 527 Devon St., Arlington, N. J.

ALCOTT, ARTHUR DAVID, '07. McMinnville, Tenn.

ALDEN, FRED NAGLEY, '10. Home Telephone Co., San Diego, Cal.

ALDEN, GEORGE IRO, M.M.E., '90. Pres. Norton Companies, Worcester, Mass. (2) Norton Grinding Co., Worcester, Mass. (1) and (3) 48 Queen St., Worcester, Mass. A. S. M. E.

ALDREDGE, H. R., M.E., '13. (2) and (3) Care Dallas Trust and Savings Bank, Dallas, Texas. (1) 359 Gaston Ave., Dallas, Texas.

ALDRICH, ELLIOTT FOURNIER, M.E., '92. Mgr., Eibel Process Co. (2) and (3) 141 Milk St., Boston, Mass. (1) 79 Elm Ave., Wollaston, Mass.

ALDRICH, GUY WILLIS. Draftsman and Asst. Engr., Metropolitan Engrg. Co. (2) and (3) 1250 Atlantic Ave., Brooklyn, N. Y. (1) 97 Kenmore Place, Brooklyn, N. Y.

ALDRICH, WICKHAM H., M.E., '04. Supt. of Power House, Clev. El. Ill. Co. (2) and (3) Cleveland Electric Ill. Co., Cleveland, O. (1) 2040 Hearns Rd., Cleveland, O.

ALEXANDER, CHARLES ANDERSON, M.E., '97. Engr. and Contractor. Pres. Alexander, Shumway & Utz Co. (2) and (3) 16 State St., Rochester, N. Y. (1) 64 Correll St., Rochester, N. Y. A. S. M. E.

ALEXANDER, DONALD, M.E., '14. University Club of Evanston, Evanston, Ill.

ALEXANDER, EDWARD RENICK, M.E. '01. (1) Drift Haven, Bratenohl, O. (2) and (3) Garfield Bldg., Cleveland, O.

ALEXANDER, ELIAS SCARR, '13. Home: 1804 S. Boulevard, Charlotte N. C.

ALEXANDER, ROBERT L., M.E., '00. Supt. West Allis Works, Allis Chalmers Mfg. Co. (1) 579 68th Ave., West Allis, Wis. (2) and (3) Allis Chalmers Mfg. Co., West Allis, Wis. A. I. E. E.

ALEXANDER, WILLIAM CRICHTON, '05. 1005 Bass Ave., Memphis, Tenn.

ALLAN, CHARLES DAVIES, '94. Evans, Almirall & Co., 1208 Monadnock Bldg., Chicago, Ill.

ALLBRIGHT, JOHN GLOVER, M.E., '17. 4937 Dorchester Ave., Chicago, Ill.

ALLEN, AMOS GREEN, '04. (2) and (3) 812-133 Washington St., Chicago, Ill. (1) 7211 Oglesby Ave., Chicago, Ill.

ALLEN, CHARLES CINCH, M.E., '10. 704 Wilson Bldg., Dallas, Tex.

ALLEN, CARL GEORGE, M.E., '05. Banker—Banking. (2) and (3) National City Bank, 55 Wall St., New York, N. Y. (1) Dobbs Ferry, N. Y.

ALLEN, CHARLES LELLAN, M.E., '10. (1) 5040 Vernon Ave., St. Louis, Mo. (2) and (3) 1118 Maple Place, St. Louis, Mo.

ALLEN, HENRY LUMMIS, M.E., '10. 2601 S. Washington St., Vicksburg, Miss.

ALLEN, HARRY JEROME, '06. Dental Surgeon, Colo. Bldg., Washington, D.C.

ALLEN, RALPH, M.E., '13. 418 W. 118 St., New York, N. Y.

ALLEN, ROBERT WHITING, M.E., '12. (1) 209 E. Henry St., Mt.Pleasant, Iowa. (2) and (3) Cutler Hammer Mfg. Co., Milwaukee, Wis.

ALLEN, THURMAN DAVIS, '95. Electrician. 23 E. North St., Danville, Ill.

ALLEN, WILLIAM DANIEL, M.E., '06. R. F. D. 2. Hamburg, N. Y.

ALLEN, WILLIAM GORDON, M.E., '04. Seneca Falls, N. Y.

ALLER, HOWARD LEWIS, M.E., '06. Gen. Mgr. Pacific Gas & Elect. Co. (1) 101 Coronado Road, Phoenix, Arizona. (2) and (3) 230 West Washington St., Phoenix, Arizona.

ALLINGTON, JOHN BEACH, M.E., '14. Electrical Engineer. (1) (3) 121 Fitzhugh St., Rochester, N. Y. (2) Rochester R. R. and Light Co., Rochester, N. Y.

ALLISON, MALCOLM G., M.E., '16. Engineer in Aeroplane Manufacture (1) 509 Franklin Place, Plainfield, N. J. (2) and (3) Standard Areo. Corp., Plainfield, N. J.

ALLISON, PHILIP WHALLEY, M.E., '11. Elect. Engr. and Inventor. (2) and (3) F. J. Sprague, 165 Broadway, New York City. (1) 385 Central Park West, New York City.

ALLISON, RAYMOND VANCE, '08. (2) and (3) 92 Griswold St., Detroit, Mich. (1) 82 Watson St., Detroit, Mich.

ALLPORT, HENRY HAMILTON, M.E., '14. 40 Bellevue Place, Chicago, Ill.

ALLWORK, ROLAND REGINALD, '13. Erecting Engr. (2) and (3) Shipley Construction Co., New York City. (1) Sea Cliff, N. Y.

ALMIRALL, JUAN A., M.E., '91, M.M.E., '92. Contracting Engineer. (1) 97 McDonough St., Brooklyn, N. Y. (2) and (3) 1 Dominick St., New York, N. Y. A. S. M. E., A. S. H. & V. E.

ALONSO, JUAN, M.E., '12. Asuncion, Paraguay, S. A.

AMBLER, WILLIAM, M.E., '00. Real Estate. (2) and (3) 44 The Arcade, Cleveland, O. (1) 13062 Forest Hill Rd., East Cleveland, O.

AMES, HARRY LEE, M.E., '07. (1) 137 S. Fifth St., Philadelphia, Pa. (2) and (3) Indep. Inspection Bur., Philadelphia, Pa.

AMMANN, LEO, M.E., '97. Cashier, First Natl. Bank. (1), (2) and (3) Highland, Madison Co., Ill.

AMSLER, ARTHUR CARL, M.E., '09. 11 Chautauqua St., Pittsburg, Pa.

AMSLER, OSCAR LOUIS, '00. Tracing and Draughtsman. 5510 Margaretta St., Pittsburgh, Pa.

AMSLER, WALTER O., M.E., '95, M.M.E., '97. Pres. Metro. Steel Co. (2) and (3) Wabash Bldg., Pittsburgh, Pa. (1) 129 Lincoln Ave., Edgewood Park, Pa. A. S. M. E., Eng'g Soc., West. Pa.

ANCARROW, ROBERT C., B.S. in Chem., Richmond College, '10; M.E., '14. Sec. and Treas. Aragon Peanut Mills. (1) 2003 W. Grace St., Richmond, Va. (2) and (3) Aragon Peanut Mills, Richmond, Va. Virginia Chemists Club.

ANDERSON, CHARLES PETER, '13. 324 W. 7th St., Erie, Pa.

ANDERSON, CLARK TAGGART, M.E., '05. Sales Agent, Ohio Brass Co., (1) 323 Park Ave., West, Mansfield, O. (2) and (3) Mansfield, Ohio.

ANDERSON, FRANK GIBBS, M.E., '06. Cleveland Mgr. Steam Equipment Mfg. Co. (1) 1268 Cranford Ave., Lakewood, Ohio. (2) and (3) 959 Leader Bldg., Cleveland, Ohio. Cleveland Engineering Soc.

ANDERSON, HARRY O., '07. Mining Engr. 130 Allison Ave., Washington, Pa.

ANDERSON, R. A., M.E., '16. 1390 Beretania St., Honolulu, Hawaii.

ANDERSON, WILLIAM H., M.E., '11. Asst. Engr., Board of Pub. Utilities, City Hall, Room 23, Los Angeles, Cal. A. I. E. E.

ANDREWS, BENJAMIN JR., '95. (1) 9 Montrose Apartments, Houston, Tex. (2) and (3) Chief Engr., Freeport Sulphur Co., Freeport, Texas.

ANDREWS, CHARLES BRADLEY, M.E., '02. High Bridge, New Jersey.

ANDREWS, CLARENCE RAPLEE, M.E., '08. Penn Yan, N. Y.

ANDREWS, FRANK COLSON, M.E., '97. 1330 Buttonwood St., Philadelphia, Pa.

ANDREWS, HEWITT ROGER, '13. 312 N. Main St., Athens, Pa.

ANDREWS, NATHANIEL REEVE, M.E., '04. (1) 2 Lewis Ave., Jamaica, N. Y. (2) and (3) Natl. Sugar Ref. Co. of N. J., Long Island City, N.Y.

ANDREWS, RICHARD HENRY, M.E., '11. 185 Rue Fondandége, Bordeaux, France.

ANDREWS, SAMUEL WARREN, M.E., '12. Roseburg, Ore.

ANDREWS, THOMAS H. S., M.E., '10. Secy. Andrews Construction Corporation. (1) 367 Grand Ave., Brooklyn, N. Y. (2) and (3) 120 Liberty St., New York City.

ANDREWS, WM. JOHNSTON, '94. Mech. Eng. P. O. Box 310, Raleigh, N. C. A. S. M. E.

ANDUX, MIGUEL JERONIMO, M.E., '13. 130 Lu Miguel St., Havana, Cuba.

ANKELE, MORITZ ALBERT, M.E., '09. 128 S. Second St., Newark, O.

ANNEX, GR. JAUVE, M.E., '16. Sugar Plantation. Santurce, Porto Rico, A. S. E. E.

ANNIN, WILLIAM RIGNEY, '06. (1) Ceiba Hueca, Cuba. (2) and (3) 337 Benham St., Bridgeport, Conn.

ANTHONY, CHARLES CHAPMAN, '95. Asst. Signal Engr., Penna. R. R. (1) 204 Midland Ave., Wayne, Pa. (2) and (3) Broad St. Station, Philadelphia, Pa. A. I. E. E., A. S. C. E., R. R. Signal Ass., Am. Ry. Eng. Ass.

ANTHONY, JAMES STOWELL, '93. Ex. Dept., G. E. Co. 44 Broad St., New York City.

APPEL, WILLARD SANDS, M.E., '08. (1) and (3) Nelson Ave. and Mill St., Far Rockaway, L. I. (2) Agent 127 W. 80 St., New York City.

APPLEGATE, THOMAS DAYTON, '02. Farmer. Cottage Farm, Bordentown, N. J. Box 194, Bordentown, N. J.

AQUINO, JOSÉ HERCULANO T., '77. Rio de Janeiro, Brazil.

ARBUCKLE, DONALD, M.E., '15. 1802 State St., Erie, Pa.

ARCHBOLD, WILLIAM KIBBEE, M.E., '89. Pres. Archbold Brady Co. Greenway Ave., Syracuse, N. Y.

* For convenience, we labeled the addresses of some with the figures (1), (2) and (3). They represent; (1) home, (2) business, and (3) mail.

ARCHER, George Frost, '96. Sanitary Engineer. (1) 307 W. 82 St., New York, N. Y. (2) and (3) 10 E. 43 St., New York, N. Y.

ARMAS, Juan L., M.E., '14. (1) Calle de Gamarra 28, Trujillo, Peru, S. A. (2) and (3) Apartado 36, Trujillo, Peru, S. A.

ARMENDÁPIZ, Angel Garcia, M.E., '11. 215 Manhattan Ave., New York, N. Y.

ARMS, Newton Taylor, M.E., '11. 162 Hilton Ave., Hempstead, N. Y.

ARMSTRONG, Benjamin Franklin, M.E., '14. (1) 949 S. Ridgeland Ave., Oak Park, Ill. (2) and (3) Idaho Power & Light Co., Boise, Idaho.

ARMSTRONG, Gelston Hills, '11. (1) 1918 Mt. Royal Terrace, Baltimore, Md. (2) and (3) 7816 Edgewood Ave., Swissvale, Pa.

ARMSTRONG, Harley J., M.E., '93. Mgr. Contractor Equipment Co., 522 First Ave. South, Seattle, Wash.

ARMSTRONG, Walter James, M.E., '08. Mech. Engr. Ross & Macdonald. (2) and (3) Belmont St., Montreal, Quebec. (1) 1024 Dorchester St., W. Montreal, Quebec. A. S. M. E.

ARMSTRONG, Walter J., M.E., '05. Mgr. Pulverizer & Crusher Dept. 904 Neil Ave., Columbus, Ohio. Jeffrey Mfg. Co., Columbus, Ohio.

ARNOLD, Herbert Warren, M.E., '13. (1) 312 S. 6th Ave., Tucson, Ariz. (2) and (3) Cashier, Warren Bros. Co., 16 E. Broadway, Tucson, Ariz.

ARNOLD, Percy L., M.E., '07. Teacher, Manual Training Dept. (2) East High School, Rochester, N. Y. (1) and (3) 327 Laburnum Cres., Rochester, N. Y.

ARNOLD, Turner Schuette, M.E., '08. Nat. Tube Co., McKeesport, Pa.

AROSEMENA, Pablo G., '09. Box 130, Panama, S. A.

ASCHOFFENBURG, Emile Lysle, M.E., '13. 4900 St. Charles Ave., New Orleans, La.

ASH, George, M.E., '13. 23 Armory Place, Paterson, N. J.

ASHBY, Chester, M.E., '01. 1st class Ship Draftsman, Naval Sta., Newport News, Va.

ASHCRAFT, Alan Emerson, M.E., '03. 678 Milwaukee Rd., Beloit, Wis.

ASHE, Tom Jefferys, M.E., '04. 605 Victona Ave., Westmount, Montreal, Can.

ASHLEY, Edward Gordon, M.E., '94. Proprietor, Ashley Mch. Works. (1) 393 Oxford St., Rochester, N. Y. (2) and (3) 714 University Ave., Rochester, N. Y.

ASHLEY, George Hall, M.E., '90. Geologist. U. S. Geol. Survey, Washington, D. C.

ASHMEAD, Edward Walmsley, M.E., '11. Care Fort Myers Ice & Elect. Co., Fort Meyers, Fla.

ASHMEAD, Walter Kittera, M.E., '15. (1) 102 W. Johnson St., Germantown, Phila., Pa. (2) and (3) Care Standard Oil Co., Calcutta, India.

ASHWORTH, Paul Parrish, M.E., '14. Electrical Engineer. (1) 567 S. West Temple St., Salt Lake City, Utah. (2) and (3) Kearns Bldg., Care Utah Power & Light Co., Salt Lake City, Utah.

ATKISSON, E. J., M.E., '11. Capt. Corps of Engineers, Gatun, Canal Zone, Panama.

ATKINSON, F. Kerr, M.E., '12. Instructor in E.E., Univ. of Missouri. Eng. Bldg., Columbia, Mo. A. I. E. E., I. E. S., T. B. II., H. K. N.

ATKINSON, John, M.E., '13. (1) 245 Barton St., Buffalo, N. Y. (2) and (3) 68 Lock St., Buffalo, N. Y.

ATKINSON, Kerr, M.E., '12. Asst. to Elec. Eng. (1) (2) and (3) Lehigh Valley Coal Co., Wilkes-Barre, Pa. A. I. E. E., I. E. S., T. B. II., H. K. N.

ATWATER, Henry, M.E., '06. Sales Manager, Atwater Mfg. Co. (1) 2613 Hampden Court, Chicago, Ill. (2) and (3) 1539 McCormick Bldg., Chicago, Ill.

ATWATER, Harry A., M.E., '12. Mechanical Engineer. (2) Union Stock Yard and Transit Co., Chicago, Ill. (1) and (3) 11140 S. Hayne Ave., Chicago, Ill. A. S. M. E.

ATWOOD, Charles Cassels, M.E., '01. 407 Lockwood St., Astoria, L. I.

ATWOOD, Edwin Havens, M.E., '11. (2) Mech. Engr. for Vacuum Oil Co., Olean, N. Y. (1) 130 N. 4th St., Olean, N. Y. (3) 130 N. 4th St., Olean, N. Y. A. I. E. E.

ATWOOD, Edward Snow, '03. 16 Seneca Parkway, Rochester, N. Y.

AUBURN, William Jacob, M.E., '97. Engr. 420 South Ave., Wilkinsburg, Pa.

AUCHINCLOSS, William Kent, M.E., '99. Atlantic Highlands, N. J.

AUEL, Carl Bennett, M.E., '92. Director of Standards, Processes and Materials, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. 623 Whitney Ave., Wilkinsburg, Pa. A. S. M. E., A.S. of Testing Materials, Eng. Soc. of Penn.

AUSTIN, Roger Kenneth, M.E., '16. 1910 Ave. J., Brooklyn, N. Y.

AUSTIN, Sydney Bertrand, M.E., '95. 105 S. Calvert St., Baltimore, Md.

AUSTIN, William Sumner, M.E., '96. Chief Eng. T. H. Symington Plant, Rochester, N. Y. (3) and (1) 12 Ridge Road, East Rochester, N. Y. A. S. M. E., Roch. Eng. Soc., Am. Chem. Soc.

AUTREMONT, Charles Maurice, '11. Mining, 714 Tarrey Bldg., Duluth, Minn. Home: 1401 E. 1st St., Duluth, Minn.

AVERILL, Earl Amos, M.E., '00. 341 Seneca Ave., Mt. Vernon, N. Y.

AVERILL, Willard Cushing, jr., M.E., '11. Beaumont, Tex.

AVERY, Albert Thomas, M.E., '14. Engr., Electric Boat Co. Groton, Conn.

AVERY, Floyd M., M.E., '16. (1) 44 Charles St., Ilion, N. Y. (3) Bridgeport, Conn. A. I. E. E.

AVERY, Frederick, M.E., '09. (2) and (3) Engrg. Dept., Cons. Car Heating Co., Albany, N. Y. (1) 53 Elberon Place, Albany, N. Y.

AVERY, John Serpell, M.E., '99. Bridgeford Mach. Tool Wks. 225 Mill St., Rochester, N. Y.

AVEY, Harry Thompson, M.E., '12. Teaching and Bldg. Work. (2) and (3) Ewing Christian College, Allahabad, India. (1) Blockton, Iowa.

AYAU, Manuel Samayoa, M.E., '17. 39 W. 93d St., New York City.

AYERS, Augustine R., M.E., '00. Room 1939 Grand Central Terminal, New York City.

BABBITT, Benj. T., M.E., '97. Manager, L. L. Babbitt Wire Mfgr., Clayville, N. Y.

BABCOCK, Charles E. P., '80. (2) and (3) 7 Municipal Bldg., Buffalo, N. Y. (1) 27 St. James Place, Buffalo, N. Y.

BABCOCK, Fred Monroe, '04. Poultry Farmer. Fredonia, N. Y.

BABCOCK, Linn Boyd, '72. 3948 Washington Boul., St. Louis, Mo.

BABCOCK, Raymond Gurdon, '15. Scio, N. Y.

BABBIDGE, Harold Joseph, '11. 207 Carlton Ave., Brooklyn, N. Y.

BABSON, Rea Edwin, M.E., '06. Fruit Grower. Parkdale P. O., Hood River Valley, Ore.

BACHELLÉ, Otto von, '92. 32 Charlotte St., Detroit, Mich.

BACHMAN, Charles F., M.E., '08. Engineering Assistant. (1) 86 Park Pl., Newark, N. J. (2) and (3) 50 Eppert St., E. Orange, N. J. N. E. L. A., A. E. R. A.

BACHRACH, Benjamin Charles, '96. Lawyer, 1320 Westminster Bldg., Chicago, Ill.

BACKUS, Henry Lindsley, '99. Cotton Buyer. Dernopolis, Ala.

BACKMAN, Clifford E., M.E., '16. 44 West St., Pittsfield, Mass.

BACKUS, Philip Rodman, '99. Copper City, B. C., Can.

BACKUS, William Alden, M.E., '10. Chicago Elev. R. R. Co. (1) 4631 Indiana Ave., Chicago, Ill. (2) and (3) 711 Royal Ins. Bldg., Chicago, Ill.

BACON, E. W. 438 West 6th St., Erie, Pa.

BACON, George Wood, M.E., '92. Care Ford, Bacon & Davis, New York City.

BACON, John Leonard, '11. Engrg. Dept. New York Central R. R. Grand Central Term., New York City, Room 4624.

BADE, Henry Fred, '14. (1) 376 E. Main St., Patchogue, N. Y. (2) and (3) Sheffield Car Co., 332 Portage Ave., Three Rivers, Mich.

BADENHAUSEN, Carl William, M.E., '17. Stapleton, N. Y.

BADENHAUSEN, John Phillips, M.M.E., '00. Pres. Badenhausen Co. (1) and (3) 1425 Chestnut St., Philadelphia, Pa. (2) 4307 Spruce St., Philadelphia, Pa. A. S. C. E.

BAEHR, Nathan, M.E., '12. Westinghouse Church Kerr Co. (2) 37 Wall St., New York City. (1) and (3) 51 E. 96th St., New York City.

BAGGERLY, Herman Douglas, M.E., '06. (1) 604 Greenwood Ave., Pottsville, Pa. (2) and (3) C. & I. Bldg., Pottsville, Pa.

BAGGS, Ralph L., '09. Mfg. Agent, (gloves). (1) 211 W. 78th St., New York City. (2) and (3) 366 Broadway, New York City.

BAHN, Carl Edward, M.E., '16. Optical Engr. (2) Bausch and Lomb Opt. Co., Rochester, N. Y. (1) and (3) 92 Huntington Park, Rochester, N. Y. A. S. M. E., Philomath.

BAHNEY, Robert Hubbard, M.E., '17. 516 E. Main St., Massillon, O. Eta Kappa Nu.

BAILEY, Caroll Elliott, M.E., '96. 43 Exchange Pl., New York City.

BAILEY, Edwin James, jr., '09. Box 35, Ellenville, N. Y.

BAILEY, Frederick W., M.E., '01. Chief Draftsman, Buffalo Forge Co. (2) 490 Broadway, Buffalo. (1) and (3) 222 Loring Ave. A. S. M. E. (Junior).

BAILEY, Hervey S., M.E., '08. 214 E. 2 St., Xenia, O.

BAILEY, Orrin, '03. Mech. Engr., Manasquan, N. J.

BAILEY, Theodorus S., M.E., '96. Electric Boat Co., Groton, Conn. A. S. M. E., Tau Beta Pi.

BAILLIÈRE, Marion V., M.E., '07. Mech. Engr. Lines, N. Y. C. R. R. Co. (2) W. 3d & St. Clair St., Cleveland, O. (1) 151 W. Main St., Norwalk, Ohio. (3) P. O. Box 311, Norwalk, Ohio. A. S. M. E.

BAINS, Thomas Mellor, jr., '99. (2) Mining Engr., Whitlock, Cal. (1) and (3) Mt. Bullion, Cal.

BAIR, Kenneth Henry, '11. Greensburg, Pa.

BAIRD, Clarence Henry, '05. Holley & Baird Realty Co., 30 Cobirg St., Winnipeg, Manitoba.

BAIRD, Warner Green, M.E., '08. (1) 927 Michigan Ave., Evanston, Ill. (2) and (3) 4555 Broadway, Chicago, Ill.

BAKER, Charles Schenck, M.E., '09. 313 Baldwin St., Elmira, N. Y.

BAKER, Edward Stuart, '07. 203 Fayette St., Staunton, Va.

BAKER, Elbert Hall, jr., M.E., '11. Emerson Co., Tacoma, Wash.

BAKER, Enos H., M.E., '16. With Goodyear Tire & Rubber Co. (1) 11 Audubon Court, Indianapolis, Ind. (2) Goodyear Tire & Rubber Co., Akron, O. (3) 70 Hamilton Ave., Akron, O. Tau Beta Pi.

BAKER, Erich Frederick, '11. Wickes Boiler Co. 90 West St., New York, N. Y.

BAKER, Horace Patton, '08. 2020 N. 22d St., Philadelphia, Pa.

BAKER, James Harvey, M.E., '07. Engr. 33 W. Upsal St., Germantown, Pa.

BAKER, James N., M.E., '05. Elect. Eng., R. Hoe & Co. (2) R. Hoe & Co., 504 Grand St., N. Y. City. (1) and (3) 1103 Lincoln Place, Brooklyn. A. I. E. E.

BAKER, Linnaeus Earl, M.E., '06. (1) Box 56, Otterbein, Ind.

BAKER, Norman Lockyer, M.E., '05. (1) 156 Clifton Ave., Chicago, Ill. (2) and (3) 1439 E 67 Place, Chicago, Ill.

BAKER, Ross Lee, M.E., '07. Elec. Engr. for Doherty & Co., 60 Wall St., New York City.

BAKER, Thomas Wallace, M.E., '08. Norton Griffiths Steel Cons. Co. Vancouver, B. C., Can.

BAKER, Walter, M.E., '17. Jena, La.

BAKER, William Hogg, '01. Asst. Gen. Supt. Atlas Portland Cement Co. (1) and (2) Box 603, Hannibal Mo. A. S. M. E., Engr. Club, New York, Racquet Club, St. Louis.

BAKER, Webster Noyes, M.E., '15. Engr. Bureau of Tests, Int'l Paper Co., (2) and (3) Glens Falls, N. Y. (1) Dansville, N. Y. Tau Beta Pi.

BAKEWELL, Joseph Hunter, '03. 5812 Baun St., Pittsburgh, Pa.

BALCH, Allan Christopher, M.E., '89. San Joaquin Light & Power Corp. (1) Hotel Alexandria, Los Angeles, Cal. (2) and (3) 805 Garland Bldg., Los Angeles, Cal.

BALCKE, Walter Henry, M.E., '07. In Eng. Dept., Stone & Webster Eng. Corp. (2) and (3) 147 Milk St., Boston, Mass. (1) 12 Wilson St., Winchester, Mass.

BALDWIN, Abram Turnure, '93. Pres. and Gen'l Mgr., Precision Instr. Co. (2) and (3) Kerr Bldg., Fort and Beaubien Sts., Detroit, Mich. (1) 171 McDougall Ave., Detroit, Mich. A. S. M. E., Detroit Eng. Soc.

BALDWIN, Austin Guy, '99. Mfr., Emigracion 1, Mexico City, Mexico.

BALDWIN, Alfred Willett, M.E., '12. Office Mgr. (1) 82 Pierrepont St., Brooklyn, N. Y. (2) and (3) Care Wagner Electric Mfg. Co., 30 Church St., New York City. Tau Beta Pi.

BALDWIN, Charles Goddard, M.E., '17. 520 Oak St., Syracuse, N. Y.

BALDWIN, Charles Summers, '10. (1) 16 Church St., Summerville, Pa.

BALDWIN, Josiah Morris, '09. 222 Montgomery, Ala.

BALDWIN, Seward, '93. Mfr., Erie St., Waverly, N. Y. (1) and (3) 476 Penn. Ave., Waverly, N. Y.

BALDWIN, Walter Hull, M.E., '89. Asst. Gen. Mgr., Adams & Westlake Co. 319 W. Ontario St., Chicago, Ill.

BALDWIN, Winfred Montgomery, M.E., '05. (1) 703 E. Walnut St., Springfield, Mo. (2) and (3) R. Baldwin Hardware Co., Springfield, Mo.

BALL, William Burnham, M.E., '13. (2) and (3) Care Turner Constr. Co., New York City. (1) 127 Winslow St., Watertown, N. Y.

BALLANCE, Willis Henry, jr., M.E., '06. Pres. Gipps Brew. Co. (1) 1319 Hamilton St., Peoria, Ill.

BALLANTYNE, Norman F., M.E., '93. 110 Hawthorne Ave., Ottawa, Can. Can. Soc. of Civil Eng.

BALLANTYNE, William Carter, M.E., '12. (1) 1328 Vermont Ave., Washington, D. C. (2) and (3) 1409 F. St., N. W., Washington, D. C.

BALLARD, Frederick Wayne, '96. Consulting Engr. (1) 1849 Cadwell Ave., Cleveland Heights, Ohio. (2) and (3) 811 Surtland Bldg., Cleveland, Ohio.

BALLARD, George Theodore, '02. Certified Public Accountant. (1) 1025 Park Ave., Utica, N. Y. (2) 52 Mann Bldg., Utica.

BALLARD, Walter Angus, '93. 328 Union St., Springfield, Mass.

BALLARD, William Cyrus, jr., M.E., '10. Instructor, Cornell University. Ithaca, N. Y.

BALLINGER, Philippi Fazio, M.E., '04. Care Southern Cotton Oil Co., Savannah, Ga.

BALLADUR, Charles Paul, '95. Care P. J. Balladur & Son, Smyrna, Asia Minor.

BALLOU, Clarence Maturin, M.E., '07. 641 Park Way, Monessen, Pa.

BALLOU, John McKnight, M.E., '15. (1) 84 Mill St., Newton, N. J. (2) and (3) Care Ford Marine Appliance Co., New York City.

BALLOU, Latimer Willis, M.M.E., '96. Agent, Guerin Spinning Co. 75 Harris Ave., Woonsocket, R. I.

BALSLEY, James Robinson, '14. 204 Biddle Ave., Wilkinsburg, Pa. (2) and (3) Harris Pumps Co., Pittsburgh, Pa.

BAMBERGER, CLARENCE GREENWALD, M.E., '08. Mining Engineer (for self). 161 Main St., Salt Lake City, Utah.

BAMMAN, AUGUST HARRY, M.E., '16. Miami, Arizona.

BAN, RYUJI, '14. Engineer-in-chief. (1) Ushigome, Tokyo, Japan. (2) and (3) Kami-Utashinai Colliery, Hokkaido, Tokyo, Japan.

BANCEL, ALFRED FERDINAND, M.E., '17. 166 E. 67th St., New York City.

BANCEL, PAUL AUGUST, M.E., '09. Engineer with Geo. H. Gibson Co. (1) 37 Weston St., Nutley, N. J. (2) and (3) Tribune Bldg., New York City. A. S. M. E.

BANGS, HOWARD RUSSELL, '14. Boston Post, Boston, Mass.

BANKS, DAVIES KIRKLAND, M.E., '17 B.S., St. Mathews, S. C. Eta Kappa Nu, Tau Beta Pi.

BANKS, MARION HOUSER, '11. Elec. Engr. St. Matthews, S. C.

BANNERMAN, FRANK, JR., '99. 426 Homestead Ave., Mt. Vernon, N. Y.

BANNING, HANCOCK, JR., M.E., '16. 504 Pacific Elec. Bldg., Los Angeles, Cal. 240 West Adam St., Los Angeles, Cal. Student A. I. E. E.

BANNISTER, ALFRED EDWARD, '13. 3300 Landon Rd., Duluth, Minn.

BANNISTER, ALFRED HENNEN, Sp. M.E., '12. Hawesville, N. Y.

BARBER, ARTHUR HOUGHTON, M.E., '10. (1) Box 394, E. Greenwich, R. I. (2) and (3) 31 Mill St., Boston, Mass.

BARBER, RALP SPANGLER, M.E., '17. 401 Union St., Joliet, Ill.

BARBOSA, JAYNE VILLARES, '99. Address not known.

BARBOUR, DANA LITTLE, M.E., '10. Ridgway Dynamo & Engine Co. 420 Hyde Ave., Ridgway, Pa. Tau Beta Pi, Eta Kappa Nu, A. I. E. E.

BARBOUR, GEORGE HARRY, M.E., '97. Engr., Patent Sales & Promotion. (1) and (3) Breckride Northfield Ave., West Orange, N. J. (2) 82 Wall St., New York City. National Geographical Soc.

BARCLAY, WILBUR EDWARD, '09. 580 Galena St., Aurora, Ill.

BARD, CHARLES MILTON, M.E., '13. Home 67 North St., Gloversville, N. Y.

BARD, FRANCIS NORWOOD, M.E., '04. Vice-Pres. and Mgr. Barco Brass and Joint Co. (1) Highland Park, Ill. (2) 212 W. Illinois St., Chicago, Ill. Western Railway Club.

BARDIUS, WARD NELSON, '99. West Winfield, N. Y.

BARDO, BENJAMIN FRANKLIN, M.E., '13. New Haven & Hartford R. R. Co. (1) Hotel Taft, New Haven, Conn. A. S. M. E., A. I. E. E., T B II, H. K. N.

BARKER, ALDEN FRANK, '06. Clayton, N. Y.

BARKER, JOHN CALVIN, '12. (1) 2144 Madison Ave., Toledo, Ohio. (2) and (3) Adv. Dept., White Auto Co., Cleveland, O.

BARKER, JAMES FRANCIS, M.E., '93. Principal. Tech. High School, Cleveland, O.

BARLOW, CONE, '09. Purchasing Agent, Munising Paper Co. (2) and (3) Munising, Mich. (1) 2140 Lincoln Park West, Chicago, Ill.

BARLOW, FRASER GEORGE, M.E., '13. R. F. D. 10., Medina, N. Y.

BARNARD, WILLIAM NICHOLS, M.E., '97. Professor of Power Engrg. (2) Sibley College, Cornell University, Ithaca, N. Y. (3) and (1) 7 South Ave., Ithaca, N. Y. A. S. M. E., S. P. E. E., Σ Xi, T. B. Pi.

BARNES, ALBERT, M.M.E., '99. Pres. and Treas. Greenville Mantel & Mfg. Co., Greenville, S. C.

BARNES, ELIPHALET AUSTIN, M.E., '99. Semet Solvay Co. 1311 Madison St., Syracuse, N. Y.

BARNES, FRED SHARES, '11. Hotel Flanders, 135 W. 47th St., New York City.

BARNES, GEORGE WARREN, '94. 118 E. Fayette St., Syracuse, N. Y.

BARNES, STUART GRAY, M.E., '92. Asst. Engr., Solvay Process Co. (1) 310 W. Boulevard, Detroit, Mich. (2) and (3) Detroit, Mich.

BARNES, WILLIAM E., M.E., '95. Supt. Plate Glass Mfg. (1) 519 E. 10th Ave., Tarentum, Pa. (2) Creighton, Pa.

BARNES, WILBUR JAMES, M.E., '15. 803 Allison St., N. W., Washington, D. C.

BARNEY, CHARLES R., '04. Telephone Engineer, West. Elect. Co. (1) 520 N. Grove St., E. Orange, N. J. (2) and (3) 463 West St., New York, N. Y.

BARNEY, JESSE EDMUND, M.E., '99. Arc Lamp Engr., D. & S. Engrg. Dept., Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

BARNHART, CLARENCE DAVIS, M.E., '05. Engr. (1) 550 Eastern Parkway, Brooklyn, N. Y. (2) and (3) 50 Church St. New York City.

BARNUM, C. LESLIE, M.E., '09. Mech. Engr., J. B. King & Co. (2) New Brighton, N. Y. (1) and (3) 67 Clinton Ave., New Brighton. A. S. M. E.

BARNUM, VICTOR BAYARD, '06. Centreville, N. Y.

BARNUM, WARD, M.E., '93. Senior Elec. Engr., Interstate Commerce Commission. (2) and (3) Rm. 34, Municipal Bldg., Chattanooga, Tenn. (1) Apt. 10. 119 E. Court St., Cincinnati, O.

BARR, CHARLES JAMES, M.E., '93. Gen. Supt. Tenn. Coal Iron & R. R. Co., Ensley, Ala.

BARR, JOHN HENRY, JR., M.E., '13. (1) 6-6 Snowdon Apartment House, Syracuse, N. Y. (2) and (3) 813 James St., Syracuse, N. Y.

BARR, JOHN HENRY, M.M.E., '89. Chief Engr. 293 Broadway, New York City. 2345 Broadway, New York City. A. S. M. E., A. A. A. S., Sigma Xi, Tau Beta Pi, etc.

BARR, SAMUEL MAX, M.E., '17. 475 Sutter Ave., Brooklyn, N. Y. A. I. E. E., A. S. M. E.

BARRACLOUGH, S. HENRY, M.M.E., '94. Russell School of Eng., Univ. of Sidney, N. S. A., Australia.

BARRETT, CHARLES GODWIN, M.E., '11. 1154 Iranistan Ave., Bridgeport, Conn.

BARROLL, HENRY EDWARD, '05. 3 Bank Bldg., Winnetka, Ill.

DE BARROS, JOSÉ LEONEL, '12. Address Unknown.

BARROS, VICENTE, JR., '15. 11 Itambé, Sao Paulo, Brazil.

DE BARROS, CARLOS PAES, JR., '04. 20 Rua Santa Ephygenia, Sao Paulo, Brazil.

BARROWS, LEE EARL, M.E., '07. The Texas Co., Box 983, Fort Worth, Tex.

BARRY, CHARLES EDWARD, M.E., '96. Mgr., S. A. Dept., H. W. Peabody & Co. (2) and (3) 17 State St., New York City. (1) 83 S. Fullerton Ave., Montclair, N. J.

BARRY, FRED WESLEY, M.E., '94. Barry Supply Co. (2) and (3) 705 May Bldg., Pittsburg. (1) 664 Hamilton Road, Thornburg, Pittsburg.

BARRY, JAMES HENRY, M.E., '10. Sales Manager. (2) and (3) Miller Supply Co., Huntington, W. Va. (1) Huntington, W. Va.

BARRY, RALPH ENSWORTH, '95. Address not known.

BARTH, IRA STEINER, M.E., '04. Westminster, Md.

BARTHOLOMAY, HERMAN, M.E., '07. Vice-Pres. and Treas. "Bartholomay Inc." Insurance. (1) 4878 Sheridan Road, Chicago, Ill. (2) and (3) Insurance Exchange, Chicago, Ill.

BARTHOLOMEW, ROBERT, M.E., '15. (2) and (3) Remington Arms Co., Bridgeport, Conn. (1) 28 High St., Glen Ridge, N. J.

BARTHOLOMEW, WALTER LEE, M.E., '10. 616 N. Cayuga St., Ithaca, N. Y.

BARTLETT, HARRY GRIFFITH, '03. First Lieutenant, United States Marine Corps, Washington, D. C.

BARTOLICIOUS, LUDWIG WILLIAM, M.E., '17. 3990 Park Ave., New York City. A. I. E. E.

BARTON, FRANK ARTHUR, M.E., '91. U. S. Army, Manila, P. I.

BARTON, FRANK LESLIE, '07. Union, N. Y.

BARTON, G. W., M.E., '94. Stephen Girard Bldg., Philadelphia, Pa.

BARTON, ROBERT CHARLES, M.E., '06. In charge physical appraisal, Pac. Tel. & Tel. Co. 342 Henry Bldg., Seattle, Wash.

BARTON, WILLIAM HILL, M.E., '08. Local Supt., Ash Grove Lime & Portland Cement Co. Ash Grove, Mo.

BASCOM, BURT CRAIG, M.E., '14. Mech. Engr., Curtis & Co. Mfg. Co. 5641 Van Versen Ave., St. Louis, Mo.

BASCOME, G. L., M.E., '05. Engineer, United Service Co. (1) Florence Apt., Scranton, Pa. (2) and (3) 700 Scranton Life Bldg., Scranton, Pa.

BASKERVILL, HENRY EUGENE, M.E., '89. 207 E. Franklin St., Richmond Va.

BASON, G. F., M.E., '16. Care W. H. Bason, Birmingham, Ala. A. I. E. E., A. S. M. E.

BASS, LOCKE DICKERMAN, '11. 227 W. Chestnut St., Canton, Ill.

BASSETT, CHARLES KINGMAN, M.E., '14. 691 W. Ferry St., Buffalo, N. Y.

BASSETT, R. S., M.E., '16. 691 W. Ferry St., Buffalo, N. Y.

BASSETTE, FREDERICK ANDERSON, '96. Printing and Publishing. Germona Bldg., Springfield, Mass.

BATCHELAR, EUGENE CROKER, M.E., '04. 1122 Farmer's Bank Bldg., Pittsburg, Pa.

BATCHELOR, ROBERT GILBERT, '04. 86 Chapin St., Holyoke, Mass.

BATES, FRANK HENRY, '94. Address not known.

BATES, HARRY H., M.E., '06. (1) 211 Sherman St., Joliet, Ill. (2) and (3) Care Bates Machine Co., Joliet, Ill.

BATES, JAMES LAWRENCE, M.E., '03. Draftsman. (1) 73 Bryant St., N. W., Washington, D. C. (2) and (3) Bureau of Construction & Navy Dept. Repair, Washington, D. C.

BATES, WILLIAM OSWALD, M.E., '11. 211 Sherman St., Joliet, Ill.

BATISTA, JORGE, M.E., '14. Amargura 23, Habana, Cuba.

BATTEY, KARL EDWARD, '15. (1) 175 Cleveland Ave., Buffalo, N. Y. (2) and (3) Pierce Arrow Motor Co., Buffalo, N. Y.

BAUM, ISAAC M., M.E., '03. (1) Uniontown, Pa. (2) and (3) 34 First St., San Francisco, Cal.

BAUM, ROBERT STANTON, M.E., '10. 203 Richard St., Joliet, Ill.

BAUMGARDNER, JOHN ANDREW, M.E., '05. Metallurgical Engr., Buick Motor Co. (1) 526 Avon St., Flint, Mich. (2) and (3) Care Buick Motor Co., Flint, Mich. American Society for Testing Materials.

BAUR, FREDERICK JOHN, '06. Lang's Bend, Toledo Beach, Toledo, Ohio.

BAUSCH, FREDERICK EMIL, M.M.E., '96. (1) 2906 N. 21st St., St. Louis, Mo. (2) and (3) 1607 Chemical Bldg., St. Louis, Mo.

BAXTER, ALLAN HAYDEN, M.E., '08. (1) 70 Clarendon Pl., Buffalo, N. Y. (2) and (3) 947 Ellicott Sq., Buffalo, N. Y.

BAXTER, HENRY NESMITH, M.E., '13. Care The Lyons-Atlas Co. (2) and (3) Indianapolis, Ind. (1) 2224 Central Ave., Indianapolis, Ind.

BAYNE, GEORGE HENRY, JR., M.E., '04. Care Penn. Coal & Coke Co. 17 Battery Pl., New York, N. Y.

BEACH, CARL HOFF, M.E., '03. 1212 Woodlawn St., Scranton, Pa.

BEADLE, LYNN CONSTANT, M.E., '08. Oxford, N. Y.

BEAHM, ROBERT BARCLAY, '13. (1) Sharon Hill, Pa. (2) and (3) Warren Webster Co., Hanover, Pa.

BEAL, REYNOLDS, '00. Newburgh, N. Y.

BEALS, ALBERT EBENEZER, M.E., '93. Consulting Engr., Great Lakes Engr'g Co. (1) and (3) 236 Gladstone Ave., Detroit, Mich. (2) Fishers Arcade, Detroit, Mich.

BEALS, EDWARD DUNCAN, M.E., '03. Pres. and Treas., Veneer Lumber Co. (1) and (3) 220 N. Park Ave., Neenah, Wis. (2) Care Hardwood Products Co., Neenah, Wis.

BEALS, WILLIAM BRYANT, M.E., '02. Outside Plant Engr., Chesapeak and Potomac Tel. Co. 108 E. Lexington Ave., Baltimore, Md. 4108 Fernhill Ave., Baltimore, Md. A. I. E. E., Eng. Club, Baltimore.

BEAM, JOHN VANDERBECK, '09. Pres. and Treas. Empire Stamp Co., 83 Nassau St., New York City.

BEAMAN, CHARLES LEICESTER, M.E., '08. (1) 1165 Antoine St., Detroit, Mich. (2) and (3) Care American Blower Co., Detroit, Mich.

BEAMENSDERFER, JOHN STANLEY, M.E., '11. Kingston, R. I.

BEARDSLEE, JOHN S. T., '92. Care American Bridge Co., Edgemore, Ill.

BEARDSLEE, KENNETH PHELPS, M.E., '05. Cazenovia, N. Y.

BEARDSLEE, ROBERT WINSLOW, M.E., '00. Chief Engineer Plaza Hotel. (1) 251 West 87th St., New York City. (2) and (3) Plaza Hotel, 5th Ave. and 49th St., New York City. A. I. E. E.

BEARDSLEY, MYRON FRED, M.E., '14. E. Randolph, N. Y.

BEATTIE, ARTHUR AZEL, B.M.E., '75. Architect, 5 Grand St., Gloversville, N. Y.

BEATTIE, SAMUEL MARSHALL, M.E., '11. Piedmont Mfg. Co., Piedmont, S. C.

BEATTY, HOLLIS STRONG, '03. 456 S. Rebecca St., Pittsburgh, Pa.

BEATTY, WILLIAM CHAMBERS, M.E., '03. Elephant Butte, N. Mex.

BEATY, WALTER WESTON, '96. Warren, Pa.

BEAVERS, CHARLES GAYLORD, '11. 15 Ave. & 50th St., Brooklyn, N. Y.

BECKER, HAZEL KIRKE, '07. Cotton Business, Forest City, Ark.

BECKER, THEODORE, '93. Assayer and Chemist. Garfield, Utah.

BECKER, WILLIAM D., M.E., '13. Gen. Mgr. and Sup't'y Engr. (1) 13431 Lake Ave., Cleveland, Ohio. (2) and (3) Rockefeller Bldg., Cleveland, Ohio.

BECKETT, BERGIE BARRIE, M.E., '04. 2509 Pacific Ave., San Francisco, Cal.

BECKMAN, HORATIO BLAKE, '93. Newburgh, N. Y.

BECKMAN, HARRY THEODORE, M.E., '09. (1) 251 S. Jameson Ave., Lima, Ohio. (2) and (3) Backman & Parmenter Adv. Co., Lima, O.

BECKSTRAND, ELIAS HYRUM, M.M.E., '01. Professor. Univ. of Utah, Salt Lake City, Utah.

BECKWITH, CHARLES LEACH, M.E., '16. (1) 534 Turner St., Allentown, Pa. (2) Wm. H. Taylor & Co., Allentown, Pa. (3) 250 Hamilton St., Allentown, Pa.

BECKWITH, HENRY CLAY, M.E., '03. Ravena, Ohio. Treas. and Gen. Mgr. of Beyers Machine Co.

BECKWITH, JOHN SELHEIMER, '04. Fruit Grower. (1) 177 South Main St., Albion, N. Y. (2) and (3) 43 West Ave., Albion, N. Y.

BECKWITH, WILLIAM, '09. 390 Broadway, Olneyville Sta., Providence, R. I.

BEDDOW, THOMAS ECKLEY, M.E., '09. Care The Cutler Hammer Mfg. Co., Milwaukee, Wis.

BEDELL, RAYNER MONROE, M.E., '02. (1) N. Mountain Ave., Montclair, N. J. (2) and (3) Lab. Asst. Care Peter Cooper Hewitt, New York City.

BEEBE, CHARLES NELSON, M.E., '05. 602 Bank of Ottawa Bldg., Vancouver, B. C.

BEEBE, LAWRENCE L., M.E., '06. Asst. Mech. Engr. Office of Public Roads, and Rural Engrg., Dept. of Agr., Washington, D. C. (1) 1440 Meridian Place, Washington, D. C. (2) and (3) Office of Public Roads and Rural Engrg., Washington, D. C. A. S. M. E., Amer. Soc. Testing Materials.

BEECHER, LOUIS ALLEN, M.E., '03. Superintendent, R. F. Sullivan Co. (2) Newton Lower Falls, Mass. (1) and (3) 50 Court St., Newtonville, Mass.

BEHRENS, CHARLES NEVIL, M.E., '12. Bell Tel. Co. of Penna., Harrisburg, Pa.

BEHRENS, HENRY RASICK, M.E., '12. Engineer. (1) 801 North 6th St., Harrisburg, Pa. (2) and (3) Bell Telephone Co of Penna., Harrisburg, Pa. Eng. Society of Penna., Harrisburg, Pa.

BEIDLER, JOSEPH ARTHUR, JR., M.E., '03. 1110 Hippodrome Bldg., Willoughby, O.

BEIFELD, ERNEST LESSING, '10. 3304 Calumet Ave., Chicago, Ill.
BEIN, FELIX WASHINGTON, '06. 262 W. 133 St., New York City.
BEIRNE, HUGH MATTHEW, '04. 392 Howard Ave., New Haven, Conn.
BELKNAP, WALDRON PHOENIX, '95. Banking. (1) 112 E. 80th St., New York City. (2) and (3) 16 Wall St., New York, N. Y.
BELL, ALBERT CUNNINGHAM, M.E., '95. Patent Lawyer, LL.B. (1) 1216 Elmwood Ave., Wilmette, Ill. (2) and (3) 1601 Lumber Exchange Bldg., Chicago, Ill.
BELL, BENT CARR, '13. King St., Cobourg, Ont., Canada.
BELL, HERBERT PHILANDER, M.E., '10. Chief Engr. 102 Key System Bldg. Oakland Term. Rys., Oakland, Cal.
BELL, HORACE MILTON, '99. Robinhood Powder Co., Swanton, Vt.
BELL, JESSE MERRITT, '00. Address not known.
BELLINGER, DANIEL LAWRENCE, M.E., '05. 134 Ridge St., Glens Falls, N. Y.
BELLINGER, DANIEL SPALDING, '02. Tonawanda, N. Y.
BELLINGER, ELIJAH WILLIAM, M.E., '11. Safety Engineer. (1)and(3) Canajoharie, N. Y. (2) 66 Broadway, Room 1213, New York City.
BELLIS, HERBERT FRANK, M.E., '11. 3470 Bates St., Pittsburgh, Pa.
BELLIS, WILLIAM CORNISH, M.E., '17. 19½ S. Virginia Ave., Atlantic City, N. J.
BELLOWS, BRIAN CHANDLER, M.E., '06. Asst. Traffic Engr., Am. Tel. & Tel. Co. (1) 40 High St., Glen Ridge, N. J. (2) and (3) 195 Broadway, New York City. New York Tel. Soc.
BELLOWS, ELMER ELLSWORTH, '82. Address not known.
BEMAN, MYRON CLARK, M.E., '05. 42 Oak St., Binghamton, N. Y.
BENBOW, JAMES R., M.E., '10. Clayville, N. Y.
BENDER, OSWALD LEWIS, M.E., '08. 105 S. Raleigh St., Martinsburg, W. Va.
BENDHEIM, BERTHOLD HERBERT, M.E., '07. Vice-Pres. Nerobery Elect. Co. (1) 4710 Drexel Blvd., Chicago, Ill. (2) and (3) Lytton Bldg., 14 E. Jackson St., Chicago, Ill.
BENEDICT, HEISCHEL ALBERT, M.E., '91. (2) and (3) Mech. Engr., Public Service R. R. Co., Newark, N. J. (1) 23 Glenwood Ave., East Orange, N. J. A. I. E. E., A. S. C. E.
BENEDICT, STEWART, M.E., '15. (2) 36 St. Francis St., Newark, N. J. (1) and (3) 94 S. Munn Ave., East Orange, N. J. Sigma Phi.
BENITEZ, LUIS, JR., M.E., '12. San Juan, P. R.
BENITZ, WILLIAM L., M.E., '96. Dean of Mech. Engr., (2) and (3) University Notre Dame, Ind. (1) 724 Cedar St., South Bend, Ind. K. C.
BENJAMIN, FRANKLIN ROGERS, JR., '99. Fishkill, N. Y.
BENJAMIN, JACK AUSEL, M.E., '08. 5202 Ingleside Ave., Chicago, Ill.
BENNETT, CHARLES BIGELOW, M.E., '15. Asst. Designing Engineer. (1) Aneta, N. D. (2) Wagner Elec. Mfg. Co., 6400 Plymouth Ave., St. Louis, Mo. (3) 6146 Suburban Ave., St. Louis, Mo. A. I. E. E. Engineer's Club of St. Louis.
BENNETT, HAROLD WILLIAM, '07. Address not known.
BENNETT, JAMES EWING, '94. (1) 3138 Lake Ave., Chicago, Ill. (2) and (3) 309 Postal Tel. Bldg., Chicago, Ill.
BENNETT, ORVILLE GREEN, JR., M.E., '04. Pres. General Motors Export Co., 11 Broadway, New York City.
BENNETT, RUSSELL HOWARD, '95. 136 Burnet St., Syracuse, N. Y.
BENNETT, THOMAS ARCHIE, M.E., '97. 39 Hawthorne Ave., Akron, O.
BENNETT, WILMURT ADDISON, M.E., '11. 186 W. North Ave., Atlanta, Ga.
BENORE, JOHN MORRIS, M.E., '16. 102 West 80th St., New York City.
BENSON, GEORGE FRED, M.E., '09. 29 Flower City Park, Rochester, N. Y.
BENSTER, HALSEY LUCIEN, M.E., '15. Engineer, Fairbanks, Morse & Co. (1) 1721 15th Ave., Moline, Ill. (2) Moline Scale Co., E. Moline, Ill. (3) 902 27th St., Moline, Ill. A. S. M. E.
BENTLEY, ALEXANDER NORTON, M.E., '04. Sales Manager. (1) and (3) 74 E. 17th St., Atlanta, Ga. (2) Peachtree & Baker Sts.
BENTLEY, DELANCY, '11. Real Estate Title Abstractor. (2) and (3) 47 S. Fitzhugh St., Rochester, N. Y. (1) 7 Prince Street, Rochester, N. Y.
BENTLEY, EDWARD ABRAM, '95. 216 S. 17 St., St. Louis, Mo.
BENTLEY, ERNEST WILKINSON, M.E., '94. Skinner Engine Co. 388 Vermont Ave., Rochester, Pa.
BENTLEY, LOUIS LEES, M.E., '90. Supt. Beaver Falls Factory. Armstrong Cork Co., Beaver Falls, Pa.
BENTLEY, WILTON, M.E., '98. Supt. K. W. Battery Co. (2) 1532 Michigan Ave., Chicago, Ill. (1) and (3) 308 Ashland Ave., River Forest, Ill. Elec. Vehicle Assn. of Am.
BENTON, MORRIS FULLER, M.E., '96. Asst. Mgr. of Dept., Amer. Type Founders Co. (1) 107 Crescent Ave., Plainfield, N. J. (2) and (3) 300 Communipaw Ave., Jersey City, N. J. A. S. M. E.
BERG, EDWIN VICTOR, M.E., '02. Asst. to Chief Engr. Box 634, Twin Falls, Idaho.
BERG, ROBERT CHARLES, '12. 33 Brighton Ave., East Orange, N. J.
BERGEN, CHARLES W., M.E., '00. Mfgrs. Agent. (2) and (3) 95 Liberty St., New York City. (1) Bayside, Long Island, N. Y.
BERGER, CALVIN M., '93. Canton, Ohio.
BERGER, HAROLD KUHNS, '15. 299 Union St., Jersey City, N. J.
BERGMAN, HENRY FRED, '05. Address not known.
BERKELEY, LANDON ROBINSON, M.E., '07. (2) Natl. Carbon Co., Cleveland, O. (3) Box 400, Cleveland, O.
BERLINGHOF, WILLIAM LOUIS, '13. Address not known.
BERNA, TELL SCHIRNDING, M.E., '12. Cutler-Hammer Mfg. Co. Gwynn Bldg., Cincinnati, O.
BERNARD, BENJAMIN FRANKLIN, JR., '12. 243 Chestnut St., Ashville, N. C.
BERRESFORD, ARTHUR WILLIAM, M.E., '93. Care Cutler-Hammer Co., Milwaukee, Wis.
BERREY, MAX LOUIS, '02. 15 N. Wahsatch, Colorado Springs, Colo.
BERRINI, LUIZ CARLOS, '09. Chief Engr. 28 Maranhas, Sao Paulo, Brazil.
BERRY, ARTHUR OLIN, M.E., '01. Municipal Bldg., Chattanooga, Tenn.
BERRY, CLYDE ALBION, M.E., '99. 52 Elm St., Summit, N. J.
BERRY, C. HAROLD, M.E., '12, M.M.E., '16. Asst. Prof. of Power Engineering. (1) 432 N. Aurora St., Ithaca, N. Y. (2) and (3) Sibley College, Ithaca, N. Y. Tau Beta Pi, Sigma Xi.
BERRY, MORPHY EDISON, M.M.E., '05. 332 East Park Ave., Oak Park, Ill.
BERRY, MAXWELL RUFUS, JR., M.E., '03. Care Electric Products Co., 10514 Dupont Ave., Cleveland, Ohio.
BERRYMAN, WILSON GARFIELD, M.E., '04. 36 Murray St., Flushing, Long Island, N. Y.
BERTHOLF, CHARLES HOWARD, '93. Marlboro, N. J.
BESOSA, JOSEPH CALEDONIA, '94. Ponce, Porto Rico.
BEST, E. H., '14. Oakmont, Penn.
BEST, FRED HELLER, M.E., '11. 15 Dey St., New York, N. Y.
BEST, GEO. HENRY, M.E., '13. Treasurer Best Pipe Coiling Bending & Welding Co. (1) and (3) 744 N. Negley Ave., Pittsburg. (2) 33d and R. R. Sts., Pittsburg.
BEST, RALPH EMERSON, M.E., '08. 143 Kendall Ave., Bellevue, Pa.
BESWICK, J. S., '14. 200 Caldwell Ave., Wilmerding, Pa.
BETTS, NORMAN DEWITT, M.E., '03. Engineer in Forest Prod.—U. S. Forest Service. (2) Forest Products Lab., Madison, Wis. (1) and (3) University Club, Madison, Wis.
BETTS, WILLIAM, '74. (2) President of Betts Machine Co., Wilmington, Del. (3) and (1) 1211 Gilfine Ave., Wilmington, Del.
BEVIN, SYDNEY, M.E., '08. 150 W. 76 St., New York, N. Y.
BEVIN, VICTOR LE LAMATOR, '10. 35 Warren St., New York City.
BEVINS, GEORGE HAROLD, '96. 235 Thames St., Newport, R. I.
BEYER, HERMAN EDWARD, M.E., '02. Cresson & Morris Co., Philadelphia, Pa.
BEYER, WALTER OLIVER, M.E., '02. Care Dravo-Doyle Co., 1103 Diamond Bank Bldg., Pittsburg, Pa.
BEYERL, WAYNE KARL, M.E., '13. Duane, N. Y.
BICK, HAROLD NEILAN, M.E., '17. 486 Maco St., Brooklyn, N. Y. A. S. M. E.
BICKELHAUPT, MILES H., M.E., '03. 503 Genesee St., Utica, N. Y.
BIERBAUM, CHRISTOPHER HENRY, M.E., '91. 931 Marine Bank Bldg., Buffalo, N. Y.
BIERMA, ARTHUR GRAHAM, M.E., '08. 115 Ridgewood Road, Ithaca, N. Y.
BIERMA, CHARLES ALLAN, M.E., '14. 450 Main St., Buffalo, N. Y.
BIERSACH, GEORGE ARTHUR, '14. (1) Versailles, Mo. (2) and (3) Care Beaver River Power Co., Gooding, Idaho.
BIGELOW, ARTWELL HUGH, M.E., '09. Waterloo, N. Y.
BIGELOW, OROMEL HARRY, M.E., '07. Palmyra, Wis.
BILLINGS, EDWARD BENJAMIN, JR., M.E., '14. 207 W. Gray St., Elmira, N. Y.
BILLWILLER, CHARLES JAMES, JR., M.E., '06. Nitrate Agencies Ldt. Iqueque, Chile, S. A.
BILLWILLER, ERNEST O., '08. Hydraulic Engineer. (2) and (3) 242 E. Main St., Stockton, Cal. (1) 239 E. Vine St., Stockton, Cal. A. S. C. E.
BILYEU, THOMAS, '07. Hillsboro, Oregon.
BINGHAM, ELBERT HOWARD, '96. Dept. Mgr., Solvay Process Co. Detroit, Mich.
BINGHAM, FORREST EDWARD, '78. Address not known.
BINGHAM, SAMUEL ALMERON, M.E., '05. 626 Howard St., Chicago, Ill.
BINKS, WILLIAM THOMAS, JR., M.E., '17. 913 N. George St., Rome, N. Y.
BIRCKHEAD, L. B., M.E., '12. Foreign Sales Dept., Bucyrus Co. (1) 251 Oneida St., Milwaukee, Wis. (2) and (3) South Milwaukee, Wis.
BIRCKHEAD, PETER HOFFMAN, M.E., '10. 251 Oneida St., Milwaukee, Wis.
BIRD, EDWARD JAMES, '07. 176 Newberry St., Boston, Mass.
BIRD, FREDERICK HULY, M.E., '17. Traveling Engineer. (1) 1346 E. 49 St., Chicago, Ill. (2) and (3) American Steel Fds., 332 S. Mich. Ave., Chicago, Ill.
BIRD, PAUL PERCY, M.E., '00. Care Norton & Bird. (2) and (3) Harris Trust Bldg., 111 W. Monroe St., Chicago, Ill. (1) 1514 W. Monroe St., Chicago, Ill.
BISHOP, JEROME CARSKADDAN, M.E., '12. (2) Vice-Pres. Iowa Pearl Button Co. Muscatine, Ia. (1) and (3) 414 W. 2 St., Muscatine, Ia.
BISHOP, RICHARD E., M.E., '09. Sales Engr. (2) and (3) 1201 Chestnut St., Philadelphia. (1) 160 W. Hortler St., Germantown, Pa. Engr. Club of Phil., Sons of Jove.
BISHOP, ROY NELSON, '00. 318 Crocker Bldg., San Francisco, Cal.
BISHOP, THOMAS NELSON, '12. The Edward Valve & Mfg. Co. (2) and (3) 814-843 S. Dearborn St., Chicago, Ill. (1) 328 Linden Ave., Winnetka, Ill.
BISHOP, WILLIAM SMART M.E., '06. 1935 Beacon St., Boston, Mass.
BISHOP, WILLIAM WARREN, '96. Credit Manager, 5427 Jefferson Ave., Chicago, Ill.
BISSELL, FRANKLIN BRIGHAM, M.E., '92. 390 Linwood Ave., Buffalo, N. Y.
BISSELL, GEORGE WELTON, M.E., '88. Dean of Engrg. and Prof. of M.E. (2) Mich. Agr. Coll., East Lansing, Mich. A. S. M. E., S. P. E. E.
BLACK, ALBERT, M.E., '95. Merchant, J. D. Black & Sons. Albion, Ind.
BLACK, CHARLES WILLARD, M.E., '05. 1622 Shatto St., Los Angeles, Cal.
BLACK, FOSTER, M.E., '16. 660 Putnam Ave., Brooklyn, N. Y.
BLACK, GEORGE WALTHER, M.E., '14. 1700 Park Ave., Baltimore, Md.
BLACK, HAMPTON, '06. Lafayette, Ala.
BLACK, HENRY VAN TREIS, '01. Mercersburg, Pa.
BLACK, ROY HARRY, M.E., '03. Engr. and Purch. Agent. (2) 604 Mission St., San Francisco, Cal. (1) and (3) 110 Hugo St., San Francisco, Cal.
BLACKALL, ROBERT HENRY, '94. 13105 Farmers Bank Bldg., Pittsburg, Pa.
BLACKBURN, CHARLES HENRY, '15. Engineer. (2) Hormiguero Central Corp., 63 Wall St. (1) 318 W. 57th St., New York City. (3) 146 Newburgh Ave., Beacon, N. Y.
BLACKWELL, HOWARD, M.E., '12. Master Mechanic, Worth Bros. Steel Co. Coatesville, Pa.
BLACKWELL, HOWARD CLAYTON, M.E., '05. 120 Clarkwell Ave., Upper Montclair, N. J.
BLAINE, CARLTON ALLEM, M.E., '10. Asst. Mgr. Geneva Wagon Co., Geneva, N. Y. 232 Washington St., Geneva, N. Y.
BLAIR, EDWARD JOHNSON, M.E., '05. (1) 232 S. Oak Park Ave., Oak Park, Ill. (2) and (3) 1001 Royal Ins. Bldg., Chicago, Ill.
BLAIR, GEORGE WALTER, M.E., '10. Manufacturer. Woolen Mfg. Co., Mishawka, Ind.
BLAIR, JOHN BULLARD, '99. Banker. 80 Broadway, New York, N. Y.
BLAKE, ALFRED D., M.E., '07. Managing Editor Power. (1) 4 Ohio Pl. Westerleigh, Staten Island. (2) and (3) Hill Bldg., 10th Ave. and 36th St., New York City. A. S. M. E., A. I. E. E., American Electric Railway Association.
BLAKE, CARROL, M.E., '95. Pres. Carrol Blake Const. Co. (1) and (3) 1416 St. Charles St., Birmingham, Ala. (2) 615 American Trust Bldg., Birmingham, Ala. A. S. C. E., Country Club of Birmingham, Rotary Club.
BLAKE, CLINTON FREDERICK, '94. Mechanical and Hoisting Engr. 21 Laplin St., Chicago, Ill.
BLAKE, CHARLES GILLESPIE, '14. Wholesale Jeweler. 50 Grand Ave., Ridgefield Park, N. Y.
BLAKE, DANIEL W., M.E., '94. Capt. U. S. Marine Corps, Retired. Pass Christian, Miss.
BLAKE, FRANCIS EUGENE, M.E., '99. Mech. Engr. 12 Walnut St., North Adams, Mass.
BLAKE, HAROLD D., M.E., '09. Devp. Lab., Nat. Lamp Works of G. E. Co. (1) 1937 Parkway Drive, Cleveland Hts., O. (2) and (3) Nela Park, East Cleveland, O.
BLAKE, PREBLE WILSON, Sp. M.E., '12. 223 Main St., Amesburg, Mass.
BLAKESLEE, EDWARD LEVI, M.E., '04. Blakeslee Lumber Co. 2856 Quinn St., Chicago, Ill.
BLAKESLEE, IRVIN, M.E., '06. 159 Long Ave., Du Bois, Pa.
BLAKESLEE, JOHN ROY, M.E., '02. Foreign Dept. Gen. Electric Co. (1) 369 McClellan St., Schenectady, N. Y. (2) and (3) Gen. Elec. Co., Test. Dept., Schenectady, N. Y.
BLAKESLEE, ROBERT BYRON, M.E., '99. 99 E. Long Ave., Du Bois, Pa.
BLAKESLEE, WILBUR BUNNELL, M.E., '03. Engr., Telephone Cable Plant, (2) 5 Light St., Baltimore, Md. (1) and (3) 4310 Penhurst Ave., Baltimore, Md. Balt. Tel. Soc.
BLAKESLEE, ROLLIN ASHLEY, M.E., '00. Manager Estate. Weatherly, Pa.

BLAKESLEE, CHARLES FAIRMAN, M.E., '14. 1718 N. Vine St., Hollywood, Cal.
BLANCHARD, ARTHUR S., M.E., '00. Asst. General Manager, Birdsboro Steel Foundry & Mach. Co. Reading, Pa.
BLANCHARD, ROLLO KIMBALL, M.E., '11. Neptune Miter Co., 90 West St., New York, N. Y.
BLANK, BERNARD, M.E., '13. Inspector, Penn. R. R. (2) Pavonia Car Shops, Camden, N. J. (1) and (3) 1240 Princess Ave., Camden, N. J.
BLANKENHORN, GEORGE STEVENS, '08. Chalmers Mfg. Co., Milwaukee, Wis. (1) University Club, Milwaukee, Wis.
BLIGH, ARTHUR HAMAN, '09. Draughtsman. Warsaw, N. Y.
BLINN, EDWARD ROLF, M.E., '12. Foreman, Construction Dept. (1) 1813 W. Genesee St., Syracuse, N. Y. (2) and (3) Solvay Process Co., Syracuse, N. Y.
BLISS, GEORGE SPENCER, '90. Publication Dept. Gen. Elec. Co. 11 Light St., West Lynn, Mass.
BLISS, HENRY WORTHINGTON, M.E., '09. Sinker, Davis Co. 2915 W Meridian St., Indianapolis, Ind.
BLISS, WILLIAM CARTER, M.E., '17. 4927 Lotus Ave., St. Louis, Mo. Tau Beta Pi.
BLISS, WILLIAM LORD, M.M.E., '93. 142 Buffalo Ave., Niagara Falls, N. Y.
BLOCK, WILLIAM HERMAN, JR., '11. 1908 N. Delaware St., Indianapolis, Ind.
BLODGET, HUGH YOUNG, M.E., '15. 24 Baker St., Lynn, Mass.
BLOOD, ARTHUR RAYMOND, M.E., '13. Head of Cost Dept., Riter-Cauley Mfg. Co. (1) 404 Market St., Warren, Pa. (2) Riter Cauley Mfg. Co., Pittsburgh, Pa. (3) 611 Blackburn Ave., Sewickley, Pa. Tau Beta Pi.
BLOOD, BRYANT HARMAN, M.E., '89. Works Supt., The Celluloid Co. (2) and (3) 290 Ferry St., Newark, N. J. (1) 705 DeGraw Ave., Newark, N. J. Eng. Club of N. Y., Machinery Club of N. Y.
BLOOD, CHARLES W. H., '91. S. A. Woods Mach. Co., S. Boston, Mass.
BLOOD, HAROLD LANGLEY, M.E., '13. (1) 912 W. 6th St., Plainfield, N. J. (2) and (3) Niles-Bement-Pond Co., Plainfield, N. J.
BLOOMER, CORNELIUS DU BOIS, M.E., '03. Lincoln Circle, Crestwood, Yonkers, N. Y.
BLOUNT, JOHN I., M.E., '98. Owner of J. I. Blount & Co. (1) 2768 Hanover Circle, Birmingham. (2) and (3) 742-3 Brown Marx Bldg., Birmingham, Ala.
BLUNT, ALBERT C., JR., M.E., '07. Mgr. Cost Dept., W. H. McElwain Co. (1) 18 Sterling St., West Newton, Mass. (2) and (3) 354 Congress St., Boston, Mass.
BLUNT, STANHOPE ECCLESTON, M.E., '09. Puget Sound Elec. Ry. Co., Tacoma, Wash.
BLUNT, JOHN BRUCHER, '05. Engineer, 75 Fulton St. New York City.
BLYTHE, HENRY ADAMS, '92. 1221 Citizens Bldg., Cleveland, Ohio.
BOAK, THOMAS ISAAC SLACK, M.E., '14. Factory Supt., Duratex Co. (1) 379 Hillside Ave., Newark, N. J. (2) and (3) 768 Frelinghuysen Ave., Newark, N. J.
BOARDMAN, ALBERT JAY, M.E., '08. 209 Traction Bldg., Indianapolis, Ind.
BOARDMAN, GEORGE PORTER, B.M.E., '76. Bookkeeper, Mail Order Business (side line). (1) Phelps, N. Y. (2) and (3) Box 803, 418 E. Jefferson St., Syracuse, N. Y.
BOCKIUS, GEORGE HAMLIN, M.E., '17. 1512 Cleveland Ave., N. W., Canton, O.
BODEN, JABEZ MONK, '80. Address not known.
BODLER, OSCAR WILLIAM, M.E., '01. Elec. Engr., Eastman Kodak Co. (2) Eastman Kodak Co., Rochester, N. Y. (1) and (3) Long Meadow, Pittsford, N. Y. A. I. E. E.
BOEDEKER, JOHN, M.M.E., '04. Rev. Cutter Serv., Treasury Dept. Washington, D. C.
BOEGEHOLD, ALFRED L., M.E., '15. 120 N. 6th Ave., Mount Vernon, N. Y.
BOEGEHOLD, CARL WINTER, M.E., '06. Mechanical Engineer, Estimating. (1) 334 Sargent St., Holyoke, Mass. (2) and (3) Worthington Pump and Machinery Corp., Deane Works, Holyoke, Mass.
BOEGEHOLD, EDWIN SWART, M.E., '08. 217 N. 9th St., Newark, N. J.
BOEHM, WILLIAM HENRY, M.E., '93. Supt., Dept. of Steam Boiler & Fly Wheel Insurance. (2) and (3) 92 Liberty St., New York City. (1) The Anniston, 281 Edgecomb Ave., New York City. A. S. M. E., and Engineers' Club.
BOBKER, LEOPOLD, M.E., '08. 428 Oak St., Richmond Hill, S. I., N. Y.
BOGARDUS, ARTHUR GLEASON, M.E., '12. 61 Hawthorne Ave., E. Orange, N. J.
BOGART, LORING JAY, '03. 412 Hector St., Ithaca, N. Y.
BOGERT, JAMES GORDON, M.E., '12. In State Insane Asylum, N. J.
BOGGIS, HENRY PARSONS, M.E., '17. 11421 Bellflower Rd., Cleveland, O.
BOHN, JOHN VALENTINE, '93. Address not known.
BOHNE, WILLIAM FREDERICK, JR., M.E., '01. 936 Washington Ave., New Orleans, La.
BOHRER, WALTER, M.E., '06. 211 Lorain Ave., Cincinnati, O.
BOICE, THEODORE HILL, M.E., '94. 104 Broadway, Bayonne, N. J.
BOIES, HARRY BAINBRIDGE, M.E., '16. Estimator. (1) 1215 Manor Ave., Woodhaven, N. Y. (2) and (3) Whiting Fdry. Equip. Co., Harvey, Ill.
BOLAND, FRANCIS HALSEY, M.M.E., '93, LL.B., '97. (1) San Francisco, Cal. (2) and (3) 152 Broadway, New York, N. Y.
BOLGIANO, JOSEPH RALPH, M.E., '09. Box 206, Chillicothe, Ohio.
BOLLMAN, CLAUDE F., '12. With Rockford Brass Works. (1) 512 Napoleon St., Rockford, Ill. (2) and (3) Care Rockford Brass Works, Rockford, Ill.
BOLLMAN, G. H., '16. 1014 Broadway, Kansas City, Missouri.
BOLONA, FELIPE AUGUSTO, M.E., '11. Box 175, Guayaquil, Ecuador, S. A.
BOLZE, RUDOLPH AUGUST, M.E., '10. Electrical Engineer. (1) 528 East End Ave., Pittsburgh, Pa. (2) and (3) Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa.
BOMEISLER, CHARLES MCKARAHER, M.E., '17. (1) East Orange, N. J. (2) and (3) Waycross, Ga.
BONEBRAKE, FRANK ARMSTRONG, '13. 3 E. Bellefield Apts., Pittsburg, Pa.
BONNEY, ALFRED, JR., M.E., '12. 61 Noble Rd., East Cleveland, O.
BONSALL, CHARLES SUMNER, '79. Manufacturer, 663 McKinley St., Salem, Ohio.
BONSTEEL, FREDERICK EUGENE, '96. Agricultural Engineer, Glencarlyn, Farm, Bear Lake, Pa.
BONTECOU, FRED FINCH, M.E., '97. Construction Engineer. (1) 319 Avery Ave., Detroit, Mich. (2) and (3) The Solvay Process Co., Detroit, Mich.
BONYUN, MORGAN EVAN, M.E., '97. Cassila, 3094—Santiago, Chili.
BOORAEM, J. FRANCIS, M.E., '91. Treas. and Gen'l Mgr., Amer. Enameled Brake Co., Treas. Nat. Lead Co. (1) Greenwich, Conn. (2) and (3) 52 Vanderbilt Ave., New York City. A. S. M. E., A. C. E.
BOOS, HANS CHRISTIAN, M.E., '10. Sales Mgr., Curtainless Shower Co. (2) 25 West Broadway, New York, N. Y. (1) 1905 Andrews Ave., New York City. (3) 25 West Broadway, New York City.
BOOTH, ALBERT ALVIN, M.E., '15. Inspector. (2) and (3) Care Newport News Shipbuilding & Drydock Co., Newport News, Va. (1) 30 Centre St., City Island, New York City.
BOOTH, ELMIR JAMES, M.E., '08. 801 Holden Bldg., Vancouver, B. C., Can.
BOOTH, IRVING EDWARD, B.M.E., '83. 108 Brown's Race, Rochester, N. Y.
BOOTH, QUENTIN WOODBURY, '81. 22 Brown's Race, Rochester, N. Y.
BOOTH, SAMUEL WILLIAM, JR., M.E., '09. Pres. Eng'ing Service Co. (2) 706 Laclede Gas Bldg., St. Louis, Mo. Petersburg, Va. (1) and (3) 4487 McPherson Ave., St. Louis, Mo.
BOPE, HAROLD S., M.E., '04. Asst. Mgr. of Sales, Carnegie Steel Co. (2) 1813 Ford Bldg., Detroit, Mich. (1) Stevenson Hotel, Detroit, Mich. (3) 1813 Ford Bldg., Detroit, Mich.
BORDEN, JOHN FRANCIS, M.E., '04. (2) and (3) Oliver Filter Co., San Francisco, Cal. (1) 545-55 St., Oakland, Cal.
BORDEN, JAMES MCKEE, M.E., '78. Assist. Supt. Long Island Hospital. (3) and (1) 43 W. 10th St., New York City. (2) Henry and Pacific Sts., Brooklyn. Trustee of American Institute of New York City.
BORDEN, WILLIAM AYRES, M.E., '12. 1st Lieut. C. A. C., Sandy Hook, N. J. or Care The Adjutant General of the Army, Washington, D. C.
BORDEN, ROLDEN LEE, '10. 963 Manlo Ave., Los Angeles, Cal.
BORES, H. B., M.E., '16. Care Whiting Foundry Equipment Co., Harvey, Ill.
BORING, EDWIN GARRIGUES, M.E., '08, Ph.D., '14. Instructor in Psychology 43 Morrill Hall, Ithaca, N. Y. 113 Glen Place, Ithaca, N. Y. Amer. Psychological Ass., Sigma Xi, Amer. Ass. Advance Science.
BORTON, GEORGE WILLS, '95. Pres. and Gen. Mgr., Pennsylvania Crusher Co. Stephen Girard Bldg., Philadelphia, Pa.
BOSCHE, FREDERICK DARLINGTON, '05. 625 Lafayette Ave., Buffalo, N. Y.
BOSE, SURENDRA NATH, M.E., '17, L. E. E. Barnes Hall, Ithaca, N. Y. Eta Kappa Nu, A. I. E. E.
BOSSINGER, ERNEST LAFAYETTE, M.E., '04. Master Mechanic. (1) and (3) 556 E. Woodlawn Ave., Germantown, Pa. (2) Midvale Steel Co., Germantown, Pa. A. S. M. E., Engineers Club of Philadelphia.
BOSSINGER, HARRY C., M.E., '10. Construction Foreman, G. E. Co. (2) G. E. Co., Oliver Bldg., Pittsburgh, Pa. (1) and (3) 752 Sheridan Ave., Pittsburgh, Pa. A. I. E. E.
BOSTROEM, AUGUST, JR., M.E., '06. Asst. Examiner, Patent Office, Washington, D. C.
BOSTWICK, HENRY MONTGOMERY, M.E., '01. Care Canada Westinghouse Co., Hamilton, Ont., Can.
BOSWORTH, EDWIN MAHLON, '03. 324 Franklin St., Denver, Colo.
BOSWORTH, FITCH SCOFIELD, M.E., '12. 430 Kane Place, Milwaukee, Wis.
BOSWORTH, WALTER MARSH, '90. Address not known.
BOUGHTON, JUDSON HARTWELL, M.E., '03. Mg'g Director, Great Lakes Boat Bldg., Corp'n. 333 Becker St., Milwaukee, Wis. A. S. M. E., A. I. E. E., A. E. R. A.
BOURNE, RALPH HINCKLEY, M.E., '05. 607 Rush St., Chicago, Ill.
BOWEN, HARRISON SEBA, M.E., '95. Care R. W. Hunt & Co. 1121 Rookery Bldg., Chicago, Ill.
BOWEN, ERNEST FLETCHER, '12. (1) 11 Foust St., Bellows Falls, Vt. (2) and (3) Bowen Garage Co., Charlestown, N. H.
BOWER, FRANK ALBERT, M.E., '10. U. S. Patent Office, Washington, D. C.
BOWES, JOSEPH, JR., M.E., '07. 100 Beechdale Rd., Baltimore, Md.
BOWES, LAURENCE C., M.E., '13. Inspector, Stationary Power Plants, C. R. I. & P. Ry. (1) 9556 Prospect Ave., Chicago, Ill. (2) Rm. 911, 139 W. Van Buren St., Chicago, Ill. A. S. M. E., A. I. E. E., N. A. S. E., A. R. E. E.
BOWES, THOMAS DAVID, JR., M.E., '05. Bowes & Mower. 517 Lafayette Bldg., Philadelphia, Pa.
BOWN, RALPH A., M.M.E., '15. Instructor Physics. (2) Cornell Univ., Ithaca, N. Y. (1) Fairport, N. Y. (3) 804 E. Seneca St., Ithaca, N. Y. Sigma Xi, A. I. E. E., Gamma Alpha.
BOWSER, WILFRED, '06. Care Mrs. Charles Bowser, Anchorage, Ky.
BOYCE, BENJAMAN KNOWLTON, M.E., '07. Telephone Engineer. (1) 132 Gardanhurst Ave., Upper Montclair, N. J. (2) 195 Broadway, New York City. (3) 15 Day St., New York City. A. I. E. E., A. A. A. S.
BOYCE, CHARLES FREDERICK, '00. 103 Winch Bldg., Vancouver, B. C., Canada.
BOYCE, IVAN ALBERT, M.E., '05. Clintonville, Conn.
BOYD, BLAIR MORTON, '03. Sec. of C. S. Bell Co., Hillsboro, Ohio.
BOYD, DARNALL LEGGO, M.E., '04. 929 W. Grace St., Richmond, Va.
BOYD, HARRY Alexander, '96. Sec. and Treas., Youngstown Engrg. Co. (3) and (2) 1636 Wilson Ave., Youngstown, O. (1) 273 Park Ave., Youngstown, Ohio.
BOYD, WALTER READ, M.E., '14. Care Elliot & Fischer, 4720 Sheridan Rd., Chicago, Ill.
BOYER, RUSSELL LANSON, M.E., '03. 82 Beaver St., New York, N. Y.
BOYNTON, ALBERT BEEBER, M.E., '03. Sewaren, N. J.
BOYNTON, EDWARD CARLISLE, M.E., '87. Newburgh, N. Y.
BOYNTON, HOWARD GEORGE, '15. 102 First St., Ithaca, N. Y.
BOYNTON, STUART DUNLEVY, M.E., '93. 211 E. Ontario St., Chicago, Ill.
BOYRER, WILLIAM CHARLES, M.M.E., '92. Care Public Service Commission. 154 Nassau St., New York, N. Y.
BRACHO, MIGUEL, M.E., '15. 4a de Londres 48, Mexico City, Mexico.
BRADBURY, ARNOLD LIBBY, M.E., '12. 179 Lowell St., Manchester, N. H.
BRADFORD, BAURY DEBELLERIRE, '07. Address not known.
BRADLEY, ALVA, '07. 706 Marion Bldg., Cleveland, Ohio.
BRADLEY, CHARLES WALTER, '96. Engineer, Northwestern Gas Co. 239 S. Grove Ave., Oak Park, Ill.
BRADLEY, ELMER PERCY, M.E., '07. 125 N. Allen St., Albany, N. Y.
BRADLEY, LEE R., M.E., '08. 2833 W. Madison St., Flat. B, Chicago, Ill.
BRADT, MORRIS, M.E., '13. (1) Y. M. C. A., Bldg., Erie, Pa. (2) and (3) Care General Elec. Co.
BRADY, ARTHUR PRESCOTT, M.E., '13. (1) 420 Simpson Place, Peckskill, N. Y. (2) and (3) 115 W. 76 St., New York City.
BRADY, PAUL, D.D., '14. Dentist. 1480 Bedford Ave., Brooklyn, N. Y.
BRAFFETTE, JOHN W., M.E., '15. Broker, Armour Grain Co. (1) 300 7th Ave., La Grange, Ill. (2) 457 Produce Ex., New York. (3) 326 E. 19th St., Brooklyn, N. Y.
BRAGAW, RICHARD, M.E., '09. Asst. Mgr., Otis Elevator Co. (1) 53 Leicester Court, Detroit, Mich. (2) and (3) 260 W. Fort St., Detroit, Mich.
BRAHMER, LELAND FRANK, M.E., '08. 1333 Peoples Gas Bldg., Chicago, Ill.
BRAINERD, RAYMOND SINCLAIR, M.E., '15. Niles-Bement-Pond Co. (1) 501 Westfield Ave., Westfield, N. J. (2) and (3) 111 Broadway, New York City.
BRANAGAN, JOHN FRANCIS, '14. Manila, P. I.
BRANDEIS, ROBT. E., M.E., '97. Pres. Brandeis Mach. and Supply Co. (1) 1054 Garvin Pl., Louisville, Ky. (2) and (3) 331 W. Main St., Louisville, Ky.
BRANDT, FREDERIC THEODORE, M.E., '10. Asst. Chief Draftsman, York Mfg. Co. 37 W. Market St., York, Pa.
BRANDT, PAUL E., '04. Watch Co. Gurzelen, Bienne, Switzerland.
BRANNON, FRANK SMALL, M.E., '08. Wholesale Grocer. (2) 311-317 E. 2d St., Owensboro, Ky. (1) and (3) 602 St. Ann St., Owensboro, Ky.

BRANSON, Craig Ridgway, M.E., '01. Motive Power Inspector, Penn Lines West of Pitt. (1) and (3) 350 West Berry St., Ft. Wayne, Ind. (2) 24, Penn. Bldg., Ft. Wayne, Ind. Eng. Soc. of W. Penn. N. Y. R. R. Club, Ry. Club of Pittsburg, Western Ry. Club.

BRANSON, Edward Lathrop, '95. Law Manager. 81 Garrison Ave., Battle Creek, Mich.

BRANT, Clifford Augustus, M.E., '11. Sec. and Gen. Mgr., Toms River Electric Co., (2) Toms River, N. J. (1) and (3) Highland Parkway, Toms River, N. J. A. I. E. E., A. E. R. A.

BRANT, David Wood, '91. Address not known.

BRAUN, Theodore Charles, M.E., '12. Laboratory Engineer. (1) 2224 6th Ave., Los Angeles Cal. (2) Tide Water Oil Co., Bayonne, N. J. (3) 84 W. 33d St., Bayonne, N. J. Society of Automobile Engineers.

BRAUNWORTH, Wilbur Eugene, '15. Box 16, Roseland, N. J.

BRAVO, Arthur Ernest, '13. San Juan, P. R.

Brayer, Nelson Garfield, M.E., '05. Supt. Sharon Wks., The Nat. Malleable Castings Co., Sharon Pa. (1) 4 W. Cedar St., Sharpsville, Pa. A. I. M. E., A. I. & S. I.

BRAYMER, Daniel Harvey, M.E., '08. 231 Euclid Ave., Atlanta, Ga.

BRAYTON, William Stanton, M.E., '93. 30 Church St., New York, N. Y.

BRAZIL, Augusto Cordoso de Moura, '07. Rua Guanabara 34, Rio de Janeiro, Brazil.

BRAZIER, Harry Bartol, M.E., '93. Broker. (1) Wynnewood, Philadelphia, Pa. (2) and (3) 1417 Chestnut St., Philadelphia, Pa.

BRECKENRIDGE, Arthur Gates, '89. Proofreader. (1) 14 Park Terrace, Binghamton N. Y. (2) and (3) Binghamton Press, Binghamton, N. Y.

BRECKENRIDGE, Clarence Edward, M.E., '00. Asst. Chief Engr., Aetna Explosives Co., Inc. (2) 120 Broadway, New York City. (1) and (3) 17 Fairview Ave., Madison, N. Y. A. S. M. E., Am. Electrochem. Soc., Am. Ass. Adv. Science.

BREEDEN, Bernard Myers, '04. Address not known.

BREMER, Lewis, jr., '08. 1925 N. Broad St., Philadelphia, Pa.

BRENDLINGER, George Frederick, '96. Cambridge City, Ind.

BRENNAN, Leo J., M.E., '14. Experimental Dept., Std. Underground Cable Co. (1) 288 Lincoln St., Flushing, N. Y. (2) and (3) 228 High St., Perth Amboy, N. J.

de BRETTEVILLE, Gustav, Spec. M.E., '10. 1024 Francisco St., San Francisco, Cal.

BREWER, Fred Jackson, '12. (1) 430 N. Geneva St., Ithaca, N. Y. (2) and (3) 1218 Madison Ave., S. Milwaukee, Wis.

BREWER, Henry, M.E., '94. Box 135, Beloit, Wis.

BREWER, R. Irwin, M.E., '17. Syracuse Lighting Co., Fulton St. Sta., Syracuse, N. Y.

BREWRINK, John Edward, M.E., '07. 952 Ogden Ave., New York City.

BREWSTER, Alfred Alexander, M.E., '04. Care B. F. Goodrich Co., Akron, Ohio.

BREWSTER, Henry B., M.E., '98. Engineer with H. S. Kerbaugh Inc. Eng. Construction. (1) 134 Holland St., Syracuse, N. Y. (2) and (3) Box 383, Rochester, N. Y. Am. Soc. C. E., A. S. M. E.

BREWSTER, James Nicholas Sevar, jr., '11. 778 Newark Ave., Elizabeth, N. J.

BRICE, Norman Earle, M.E., '11. (1) R. F. D. 1, Annapolis, Md. (2) and (3) Care Baltimore Sewerage Commission, 1602 Madison Ave., Baltimore, Md.

BRIGGS, Lynn Hazeltine, '00. Address not known.

BRIGHT, Micheal Carnahan, M.E., '17. 399 W. 4th St., Superior, Wis.

BRILL, George Mackensie, M.M.E., '95. Box 143, Berkeley, Cal.

BRINCKERHOFF, Charles Fuller, jr., '05. Grand Central Terminal, New York City.

BRINCKERHOFF, James Embury, M.E., '17. 140 Berkeley Ave., Orange, N. J.

BRINER, Emil Amandus, M.E., '01. Eastern Mgr. N. Y. Blower Co. (2) and (3) 12 Railroad Pl., E. Orange, N. J. (1) 489 Central Ave., E. Orange, N. J.

BRINES, Oscar William, '02. 221 W. 122 St., New York City.

BRINKERHOFF, Albert David, M.E., '05. 1313 S. 8th St., Waco, Texas.

BRINKLEY, Ben Hampton, '05. Address not known.

BRINSMADE, Louis Lyon, M.M.E., '97. 165 Broadway, New York, N. Y.

BRINTON, Charles Chester, M.E., '08. (1) 322 Jackson St., Butte, Mont. (2) and (3) 402 Gray Bldg., Wilkinsburg, Pa.

BRISTOL, George Treat, '12. 236 Gates Ave., Brooklyn, N. Y.

BRITTEN, Edwin Franklin, jr., M.E., '07. Care Joseph Bardsley Mfg. Co. 151 Baxter St., New York, N. Y.

BRITTON, J. Arthur, M.E., '96. Gen. Mgr., Penn Lighting Co. (1) and (3) 321 E. Dewart St., Shamokin, Pa. (2) 101 W. Independence St., Shamokin, Pa.

BRITTON, Karl Beckwith, M.E.,'06. Pres. The Britton Carburetor Mfg. Co. (1) 66 Wadena St., E. Cleveland, Ohio. (2) and (3) Caxton Bldg., Cleveland, Ohio. S. A. E.

BRITTON, Richard Hamilton, '97. 50 Union Square, New York City.

BRIZSÉ, Norman Charles, '01. 542 West Broadway, New York City.

BROADFOOT, William Gillies, M.E., '12. (1) Fayetteville, N. C. (2) and (3) Concord, N. C.

BROADWIN, S., '13. 9 East 107 St., New York, N. Y.

BROCKSMIT, John Cornelius, M.E., '99. 827 S. 6th St., Cedar Rapids, Ia.

BROCKWAY, George Porter, M.E., '12. Engr. Electric Heating Dept. (2) and (3) Care Cutler Hammer Mfg. Co., 144th St. and S. Blvd., New York City. (1) 630 East 176th St., New York City.

BRODHEAD, Alex. L., M.E., '95. Sec'y Emanuel & Company. (1) Front Street, Catasauqua, Pa. (2) and (3) 317 Bridge St., Catasauqua, Pa. A. S. M. E.

BRODIE, Walter, '96. 50 Broad St., New York City.

BRODT, John Henry, M.E., '13. Sales Engr., Crittall Casement Window Co. (1) 285 West Gd. Boulevard, Detroit, Mich. (2) and (3) 685 East Atwater St., Detroit, Mich.

BROGAN, John Ernest, '06. 2532 Chestnut St., New Orleans, La.

BROGUET, Fernando Jose, M.E., '09. Parana E. Rios, Arg. Rep.

BROMLEY, John Hallock, M.E., '09. Plattsburg, N. Y.

BRONSON, Carlos Emerson, M.E., '10. Mech. Engr. (1) and (3) 518 Elliott St., Kewanee, Ill. (2) Care Kewanee Boiler Co., Kewanee, Ill. A. S. M. E., A. A. E.

BRONSON, Frank Percival, '11. N. Y. Central & H. R. R. R. 70 E. 45th St., New York City.

BRONSON, Gerritt Catlin, '97. Clinton, N. Y.

BROOKINS, William Van Rensselaer, '06. Box 87, Newfane, N. Y.

BROOKMAN, H. D., '00. East Liverpool, O.

BROOKMAN, Horace Dwight, '09. Trenle China Co., E. Liverpool, O. (1) 818 Lincoln Ave., E. Liverpool, O.

BROOKS, Burton Hotchkiss, M.E., '97. (1) 44 Wilson Ave., Columbus, Ohio. (2) and (3) Ohio State Tel. Co., Columbus, O.

BROOKS, Henry Neimeyer, M.E., '88. 4809 Sheridan Road, Chicago, Ill.

BROOKS, Henry Warren, M.E., '11. 315 Pacific Ave., Webster Groves, Mo.

BROOKS, John Prentice, M.E., '10. 341 W. 3d St., Elyria, Ohio.

BROSSEAU, Joseph Edward, M.E., '11. 406 Barry Ave., Chicago, Ill.

BROUGH, Charles Y., '05. One-half owner Retail Lumber Yard, Hanover, Pa.

BROUGHTON, Henry Primm, M.E., '90. Crown Point, Ind.

BROWD, Paul Konstance, M.E., '91. Kanatnaja St., Odessa, Russia.

BROWN, Albert Winton, M.E., '96. (1) Hempstead, N. Y. (2) and (3) Lawyer, 27 Cedar St., New York City.

BROWN, Benj. Crissey, M.E., '13. Acting Supt., Milton Mill. (2) and (3) Int'l Paper Co., Milton, Vt. (1) Norfolk, Conn.

BROWN, Clifton Andrew, M.E., '13. Bemus Pt., Chautauqua Co., N. Y.

BROWN, Charles Baucher, '04. Care Standard Oil Co., Kiang, China.

BROWN, Carlton Emerson, '98. 1208 Monadnock Bldg., Chicago, Ill.

BROWN, Carrol Gardner, M.E., '14. Instr. Sibley College, 120 Miller St., Ithaca, N. Y.

BROWN, Charles Lyman, M.E., '95. Bus. Mgr., Elliott Co. 527 Monadnock Bldg., Chicago, Ill.

BROWN, Charles Seamans, M.E., '12. 608 W. Onondaga St., Syracuse, N. Y.

BROWN, Charles Wing, M.E., '12. (1) 42 South Parsons Ave., Columbus, Ohio. (2) and (3) Supt. Columbus Mill & Mine Supply Co., Columbus, Ohio.

BROWN, Clifford W., M.E., '07. Mgr. Wholesale Inc. (1) Salem, Ore. (2) and (3) Box 115, Salem, Ore.

BROWN, Clinton Willi, M.E., '13. (1) 5351 Waterman Ave., St. Louis, Mo. (2) and (3) Certified Roofing Co., St. Louis, Mo.

BROWN, Elmer Ellsworth, '12. Mt. Joy, Pa.

BROWN, Ernest H., '91. 915 Union Bank Bldg., Pittsburg, Pa.

BROWN, Frederic Dill, M.E., '02. Mgr. Huron Light & Power Co. (1) Huron, S. D. (2) and (3) Huron, S. D. A. I. E. E.

BROWN, Fred Isaac, M.E., '03. 1006 Milch St., Little Rock, Ark.

BROWN, Franklin J., '10. 2707 Hoagland Ave., Ft. Wayne, Ind.

BROWN, Garrett Hubbard, '94. W. Onondaga St., Syracuse, N. Y.

BROWN, George N., M.E., '05. (2) E. E. N. Y. State Ry's. (3) Gridley Bldg., Syracuse, N. Y. (1) 301 Slocum Ave., Syracuse, N. Y. Tech. Club of Syracuse, A. E. R. A., Chamber of Commerce, A. I. E. E.

BROWN, George Teall, '06. 91 Buckingham St., Hartford, Conn.

BROWN, George Tod, '09. Care W. L. Brown, 42 W. 72 St., New York City.

BROWN, Herbert Dunham, M.E., '10. 785 State St., Schenectady, N. Y.

BROWN, Harry Sanford, M.E., '04. Sales Mgr., Power Specialty Co. (1) 1060 Beacon St., Brookline, Mass. (2) and (3) 50 Congress St., Boston, Mass. A. S. M. E.

BROWN, Harold Warner, M.M.E., '15. (1) and (3) 213 Cornell St., Ithaca, N. Y. (2) Instructor, Cornell University.

BROWN, Henry Willett, '11. Automobile Parts Manufacturer. (1) 604 Walnut Ave., Syracuse, N. Y. (2) and (3) The Brown Co., 213 Bellevue Ave., Syracuse, N. Y.

BROWN, Herbert Childs, M.E., '05. Bell Tel. Co., Helena, Mont.

BROWN, Hugh Thomas, M.E., '95. 84 State St., Boston, Mass.

BROWN, J. Grove, M.E., '92. Groton, N. Y.

BROWN, James Leslie, M.E., '13. (1) 415 Liberty St., Flint, Mich. (2) and (3) Buick Auto Co., Flint, Mich.

BROWN, James Taylor, B.M.E., '76. 363 W. 20 St., New York, N. Y.

BROWN, John Thompson, '06. With E. I. du Pont de Nemours & Co. (1) 2406 Delaware Ave., Wilmington, Del. (2) and (3) du Pont Bldg., Wilmington, Del.

BROWN, Lyman Holden, M.E., '98. Mech. Engr. (1) 58 Harold St., Hartford, Conn. (2) and (3) Care Travelers Ins. Co., Hartford, Conn. A. S. M. E.

BROWN, Melville Gilfillan, M.E., '10. Address not known.

BROWN, Paul Goodwin, '96. Care U. S. Engine Co., 17 W. 42d St., New York City.

BROWN, R. E., M.E., '16. University of Pennsylvania, Philadelphia, Pa.

BROWN, Robert Harry, '08. 717 Cass Ave., Detroit, Mich.

BROWN, Roger Stuart, M.E., '14. 48 Elm St., Montclair, N. J.

BROWN, Samuel George, '99. Fruit Grower, Willoughby, Ohio.

BROWN, Samuel Thomas, M.E., '17. Patton, Pa.

BROWN, Sanford, '11. 49 Brunswick Rd., Montclair, N. J.

BROWN, Wallace Macdonald, '01. 124 Lincoln Pl., Brooklyn, N. Y.

BROWN, Walter Abbott, M.E., '15. (1) 1808 Rosedale St., Baltimore, Md. (2) and (3) Mt. Clare Shops, Balt. & Ohio R. R. Co., Baltimore, Md.

BROWN, Walter Frazer, '93. Medford, Oregon.

BROWN, William Clinton, B.M.E., '81. 401 S. A. & K. Bldg., Syracuse, N. Y.

BROWN, William Hiram, M.E., '93. Brown Trafilog Co., Rose Bldg., Cleveland, Ohio.

BROWN, William J., M.E., '16. (1) Mehoopany, Pa. (2) and (3) Y. M. C. A. or Genl. Delivery, Claremont, N. H.

BROWN, William Nivir, M.E., '05. Sec. and Treas. of Cooper Bros. 44 River, Cortland, N. Y. 40 River St., Cortland, N. Y.

BROWN, Willis Holt, '06. Address not known.

BROWN, Wiser, M.E., '17. With Power Specialty Co., 401 S. A. & K. Bldg., Syracuse, N. Y.

BROWN, Wylie, '98. Gen'l Sales Agent, Bridgeport Brass Co., Bridgeport, Conn.

BROWNE, Kenneth Josiah, '15. 921 Watchung Ave., Plainfield, N. J.

BROWNE, William Henry, jr., M.E., '06. 86 S. 10 St., Brooklyn, N. Y.

BROWNING, Charles, jr., M.E., '87. 1324 I St., Sacramento, Cal. 2107 22 St., Sacramento, Cal.

BROWNLEY, John Winfield, '14. 43 Raleigh Ave., Norfolk, Va.

BRUBACK, Theodore McLane, M.E., '12. Mech. Engr. (1) 812 Peach St., Erie, Pa. (2) and (3) Vulcan Soot Cleaner Co., Du Bois, Pa. A. S. M. E.

BRUCE, Harry Alexander, M.E., '05. Care N. W. Halsey & Co., Los Angeles, Cal.

BRUCE, Louis Frederick, M.E., '03. Treasurer, Vaughan & Barnes, Inc., Norfolk, Va. 914 West Graydon Ave., Norfolk, Va.

BRUCE, Oliver Standard, jr., M.E., '08. 98 Alsace Ave., Buffalo, N. Y.

BRUCKMAN, Earnest Gustave, '92. Vice-Pres. 26 Courtlandt St., New York City.

BRUCKNER, Arthur, M.E., '98. (1) Hastings-on-Hudson, N. Y. (2) and (3) Instructor in Physics and Mech. Arts in College of the City of New York.

BRUEGEL, Adolph Theodore, M.M.E., '96. Secy. and Asst. Manager. (2) and (3) Hess Bright Mfg. Co., Front St., Philadelphia, Pa. (1) Melrose Park, Philadelphia, Pa. A. S. M. E., A. A. A. S., S. P. E. E., Engrs. Club of Phila., Nat. Asso. of Mfrs.

BRUNDAGE, Floyd Collins, M.E., '06. Phoenix Constr. Co., 414 Kearns Bldg., Salt Lake City, Utah.

BRUNO, y Dominguez, Jose Antonio, '06. Guayama, Porto Rico.

BRUSTLEIN, Charles Henry, M.E., '99. 108 Lexington Ave., New York, N. Y.

BRYAN, F. C., '16. 2626 Grand Ave., New York, N. Y.

BRYANT, Fred Lafayette, M.E., '99. Consulting Engineer. Spartanburg, S. C.

BRYDE, Walter Stanley, M.E., '09. Sales Manager. (1) 254 Calhoun St., Battle Creek, Mich. (2) and (3) Advance Pump & Compressor Co., Battle Creek, Mich.

BRYE, Walter Frederick, M.E., '12. Box 94, Auburn, Cal.

BUCHANAN, Alexander Watson, M.E., '87. 1332 N. Cascade Ave., Colorado Spr., Colo.

BUCHANAN, JAMES DEWAN, M.E., '09. 41 Wendell Ave., Schenectady, N. Y.
BUCHANAN, MYRON WEBSTER, M.E., '00. Salesman. (2) Diehl Mfg. Co., Elizabeth, N. J. (1) and (3) 40 Hillside Road, Elizabeth, N. J. A.I.E.E.
BUCHANAN, PAUL RUTHERFORD, M.E., '10. 4821 Iowa Ave., Washington, D. C.
BUCK, ALONZO MORRIS, M.E., '04. Asst. Prof. of Railway Elect. Eng'ing. (2) and (3) 110 Transportation Bldg., Univ. of Illinois, Urbana, Ill. (1) 607 W. High St., Urbana, Ill. A. I. E. E., S. P. E. E., A. A. A. S., H. K. N.
BUCK, CLIFFORD ROSS, M.E., '97. (1) 5025 Knox St., Germantown, Pa. (2) and (3) Baldwin Loco. Works, Philadelphia, Pa.
BUCK, FRANK WILLIAMS, M.E., '09. Mech. Engr., Tallassee Power Co. Bradin, N. C.
BUCK, HOWARD H., '06. 67 Exchange Place, New York City.
BUCK, IRWIN, M.E., '04. Engineer. 309 Hamilton St., Albany, N. Y.
BUCKINGHAM, HENRY HINE, M.E., '03. Hysham, Mont.
BUDD, HARRY STONE, M.E., '00. (1) 1523 E. 66 Pl., Chicago, Ill. (2) and (3) 1502 Peoples Gas Bldg., Chicago.
BUCHNER, HENRY PHILIP, '13. Mt. Tabor, Portland, Oregon.
BULLARD, RALPH COMSTOCK, '03. Architect. 419 W. 121 St., New York City.
BULLIS, HAROLD EDMUND, M.E., '09. 11 Charlotte St., Toronto, Ont., Can.
BULLIS, SETH MADISON, M.E., '08. Ry. & Lt. Co., Vicksburg, Miss.
BULLOCK, STUART DICKINSON, M.E., '99. Engineer. 1234 Ohio Bldg., Toledo, O.
BUMP, ARCHIE EDMUND, '00. 39 Melville Ave., Dorchester, Mass.
BUMP, BURTON NELSON, M.E., '92. 404 Hamilton St., Syracuse, N. Y.
BUNDY, EDWIN SIMEON, JR., '11. Box 194, Syracuse, N. Y.
BUNDY, JAMES ALBERT, M.E., '11. 1110 Garland St., Flint, Mich.
BUNTING, DOUGLAS, M.E., '94. 26 W. Ross St., Wilkes-Barre, Pa.
BUNTING, SAMUEL JOSEPH, M.E., '75. Sec. Rialto Irrigation District, Bloomington, Cal.
BURD, HARRY GROVER, M.E., '09. 600 Westinghouse, Pittsburg, Pa.
BURDSALL, ELLWOOD, JR., B.M.E., '78. King St., Port Chester, N. Y.
BURGER, FRANK GUSTAVE, '07. 120 Heberton Ave., Port Richmond, Staten Island, N. Y.
BURGHER, CEDRIC, '11. Oak Lawn St., Dallas, Texas.
BURGHER, EARLE RUTHERFORD, '12. 296 E. 3d St., Beaver, Pa.
BURGOON, CHARLES ELI, M.M.E., '06. The Panama Canal, Washington, D. C.
BURKE, CHARLES FRANCIS, '11. 1820 Hancock St., Chicago, Ill.
BURKHART, JOHN CONNER, M.E., '08. (1) The Denver, 21st and Horton Sts., Portland, Ore. (2) and (3) Care W. C. Brewster, Failing Bldg., Portland, Ore.
BURLINGAME, BRUCE SEDGWICK, M.E., '03. (1) 206 Dewitt Pl., Syracuse, N. Y. (2) and (3) Care Solvay Process Co.
BURLINGHAM, CHARLES SANFORD, JR., M.E., '14. Elect. Railway Engineer (1) 315 Barnes St., Wilkinsburg, Pa. (2) and (3) Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa. A. I. E. E.
BURNHAM, L. F., M.E., '14. Mechanical Engineer. (2) and (3) 730 Noble Ave., Bridgeport, Conn. (1) 182 W. Church St., Fairport, N. Y.
BURNHAM, RAYMOND, M.E., '97. 932 E. 50th St., Chicago, Ill.
BURNS, CHARLES, M.E., '09. (1) 904 President St., Brooklyn, N. Y. (2) and (3) 44 Schermerhorn St., Brooklyn, N. Y.
BURNS, EDWARD, JR., M.E., '03. (1) 860 Prospect Place, Brooklyn, N. Y. (2) and (3) 140 Cedar St., New York, N. Y.
BURNS, JOSEPH MCLARN, M.E., '10. (2) and (3) Care McGraw Publ. Co., 239 W. 39th St., New York City. (1) 410 W. 124th St., New York City.
BURNS, WALTER WILLIAM, M.E., '06. Asst. Examiner, U. S. Patent Office. (2) and (3) 167 U. S. Patent Office, Washington, D. C. (1) Franklin, E. Falls Church, Va.
BURPEE, CHANDLER, M.E., '17. 1814 W. Venango St., Philadelphia, Pa.
BURPEE, GEORGE HERBERT, '83. Mech. Engr. 1921 H St., N. W., Washington, D. C.
BURR, DAVID EUGENE, M.E., '03. Pres. James E. Nelson Co., Contractors. (2) and (3) 7 Water St., Boston, Mass. (1) 1390 Beacon St., Brookline, Mass.
BURR, HENRY FRANK, M.E., '08. Executive Clerk, Pub. Service Ry. Co. (2) and (3) Public Service Terminal Bldg., Newark, N. J. (1) 17 Carnegie Ave., E. Orange, N. J. Terminal Club, Young Men's Bus. Club.
BURR, JONATHAN STURGES, M.E., '93. 429 Kent Ave., Brooklyn, N. Y.
BURRELL, EDWARD PARKER, M.E., '98, M.M.E., '99. 2254 E. 89 St., Cleveland, O.
BURROUGHS, HENRY HARDING, M.E., '94. 2633 Adams Mill Road, Washington, D. C.
BURROWS, EASTMAN ALBIN, '02. 918 Webster Ave., Chicago, Ill.
BURROWS, GEORGE FREDERICK, M.E., '00. Estimating Engineer. (1) 2933 E. Overlook Rd., Cleveland, Ohio. (2) and (3) Wellman, Seaver, Morgan Co., Cleveland, Ohio. Cleveland Engineering Society.
BURSLEY, JOSEPH ALDRICH, '01. Instructor Mech. Engrg., University of Michigan, 2515 Fairfield Ave., Fort Wayne, Ind.
BURT, AUSTIN, M.E., '00. 631 W. 3 Ave., Waterloo, Iowa.
BURT, GEORGE RICHARDSON, '96. 27 Orchard Ave., Battle Creek, Mich.
BURTON, PAUL GIBSON, '94. 108 E. Lexington St., Baltimore, Md.
BURTT, HUGH TINNEN, M.E., '89. 40 Pine St., Lockport, N. Y.
BURWELL, ROBERT TURNBULL, M.E., '91. 1709 Prytania St., New Orleans, La.
BURWELL, WILLIAM TURNBULL, JR., '08. (1) Cor. Mercer and Broadway, Seattle, Wash. (2) and (3) 301 New York Bldg., Seattle, Wash.
BUSCHMAN, ARTHUR WILLIAM, '13. 177 Lincoln Road, Brooklyn, N. Y.
BUSH, FREDERICK MORRISON, '91. Address not known.
BUSH, HAROLD MONTFORT, M.E., '93. Briggsdale, O.
BUSH, ROLAND ALLEN, M.E., '15. (2) and (3) Care Strathmore Paper Co., Asst. Supt., Woronoco, Mass. (1) 115 Bartlett Ave., Pittsfield, Mass.
BUSHNELL, HORACE CARLTON, M.E., '02. 276 Sackett St., Brooklyn, N. Y.
BUSHONG, JACOB, '02. Adv. Mgr., Moline, Ill.
BUTLER, EDMUND WILLIAM, M.E., '13. 533 3 St., Brooklyn, N. Y.
BUTLER, H. W., M.E., '00. 56 E. 50 St., New York City. A. I. E. E.
BUTLER, JOHN MORRIS, JR., '96. 1418 Dorris Ave., Westchester, N. Y.
BUTLER, NATHAN ROGERS, JR., M.E., '11. Jeansville Iron Works, Hazleton, Pa.
BUTLER, WM. CULLEN MORRIS, '11. Vice-Pres. and Asst. Gen. Mgr., Quarry Stripping Const. Co., Central, Pa. (2) Cor. Pine and Buttonwood Sts. (1) and (3) 91 N. Vine St., Hazleton, Pa.
BUTMAN, CARL HAWES, '11. Journalist, Editorial Asst. (1) and (3) 1810 North St., Washington, D. C. (2) Smithsonian Institution.
BUTTLEWORTH, HARRY WARNER, JR., M.E., '11. Asst. Supt., Mfg. Textile Mach'y, H. W. Butterworth & Sons Co. (2) and (3) York and Cedar Sts., Philadelphia, Pa. (1) 316 Carpenter St., Philadelphia, Pa.
BUTTON, JESSE SCOTT, '96. 60 Union Ave., Schenectady, N. Y.
BUYS, IVAN, M.E., '17. Trumansburg, N. Y.
BUZBY, PAUL MITCHELL, M.E., '15. 45 E. Central Ave., Moorestown, N. J.
CABASSA, JACOBS LUIS, M.E., '12. Box 114, Mayaguez, Porto Rico. Mail returned.
CAHEN, HAROLD ARTHUR, A.B., '13, M.E., '16. 354 Central Park West, New York City. A. S. M. E.
CAIRNS, EDWARD, '06. Sec. and Treas. of V. & O. Press Co. (1) 358 N. Fullerton Ave., Montclair, N. J. (2) and (3) The V. & O. Press Co. (Glendale), Brooklyn, N. Y.
CALDER, WILLIAM, JR., M.E., '17. 2236 N. 2d St., Harrisburg, Pa.
CALDERON, JORGE ALVAREZ, M.E., '05. Lima, Peru.
CALDERON, MANUEL ALVAREZ, '05. Lima, Peru. Mail returned.
CALDWELL, EDWARD, M.E., '88. (1) 239 W. 39 St., New York, N. Y. (2) and (3) Care McGraw-Hill Book Co.
CALDWELL, FRANK B., '12. Secy. H. W. Caldwell & Son Co. (2) and (3) 17th St. and Western Ave., Chicago, Ill. (1) 417 N. Kenilworth Ave., Oak Park, Ill.
CALDWELL, FRANCIS CARY, '91. (2) and (3) Prof. Elec. Engr., Ohio State Univ., Columbus, Ohio. (1) 206 16th Ave., Columbus, O. A. I. E. E. I. E. S., S. P. E. E., Phi Beta Kappa, H. K. N.
CALDWELL, HAROLD LIVINGSTON, '11. 156 Bay View Ave., Far Rockaway, N. Y.
CALDWELL, HENRY WALLACE, M.E., '17. 417 Kenilworth Ave., Oak Park, Ill.
CALDWELL, JAMES CLAYTON, M.E., '17. 119 Henry St., Brooklyn, N. Y. Amer. Air Compressor Works, Brooklyn, N. Y.
CALDWELL, JOHN RICHARD, M.E., '89. Newburg, N. Y.
CALDWELL, WALTER BRUCE, M.E., '12. (1) 66 Ormand Ave., Sharon, Pa. (2) and (3) National Malleable Castings Co., Sharon, Pa.
CALHOUN, TRACY JENNINGS, '08. Care Johnson & Jennings Co., 163 Jennings Ave., Cleveland, Ohio.
CALKINS, ALBERT SMITH, '08. (2) and (3) Shaw-Walker Co., 109 S. Wabash St., Chicago, Ill. (1) 4212 Berkeley Ave., Chicago, Ill.
CALKINS, JAMES BIRDSALL, M.E., '16. (2) Morse Chain Co. (3) 30 S. Albany St., Ithaca, N. Y.
CALLAGHAN, JOSEPH FRANCIS, M.E., '12. 327 Convent Ave., New York, N. Y.
CALLAHAN, JOSEPH G., M.E., '14. Mgr. Universal Inspection Co. (2) and (3) 612 Canal Bank Bldg., New Orleans, La. (1) 90 Nonotuck St., Holyoke, Mass.
CALLAN, JOHN, M.E., '17 B.E., 1721 Baronne St., New Orleans, La.
CALLIS, GEORGE RICHARD, JR., M.E., '09. 902 N. Fulton Ave., Baltimore, Md.
CALVERT, WILLIAM BELLE, '90. Real Estate and Insurance. 111-115 Dean Bldg., South Bend, Ind.
CAMERON, JAMES RICHARDSON, M.E., '09. 220 E. 4th St., Cincinnati, O.
CAMP, CHARLES FORSTER, M.E., '92. 548 50 W. 23d St., New York City.
CAMPBELL, HARRY DANA, M.E., '98. Hill Clutch Co., Cleveland, O.
CAMPBELL, JAMES ARCHIBALD, '04. 1746 E. 14 St., Brooklyn, N. Y.
CAMPBELL, JAMES CHASE, '00. Care J. C. Campbell & Co., 1025 First Natl. Bank Bldg., Chicago, Ill.
CAMPBELL, JOHN PALMER, '93. N. Y. Mills, N. Y.
CAMPBELL, JOHN SHAW, JR., '12. 415 N. Main St., Butler, Pa.
CAMPBELL, JOSEPH BATES, '11. 118 Linn St., Ithaca, N. Y.
CAMPBELL, ROBERT MORTON, M.E., '02. Care Baldwin Locomotive Works. (2) and (3) 500 N. Broad St., Philadelphia, Pa. (1) 7414 Boyer St., Mt. Airy, Pa.
CAMPBELL, THOMAS JEROME, M.E., '12. 1829 Main St., Richmond, Ind.
CAMPION, EDWARD WINSLOW, M.E., '06. Buckeye Steel Cast Co., Columbus, O.
CANADAY, MIRON SMITH, M.E., '10. 5938 S. Park Ave., Chicago, Ill.
CANAL, CARLOS JULIO, M.E., '92.
CANDEE, ALLAN HARRY, M.E., '06. West 2514 Liberty Ave., Spokane, Wash.
CANDEE, FREDERICK GREEN, '96. 632 Main St., Ventura, Cal.
CANFIELD, ALBERT HOMER, '99. (2) and (3) Care H. O. Canfield Co., Bridgeport, Conn. (1) 175 Brooklawn Ave., Bridgeport, Conn.
CANFIELD, ROBERT WITHINGTON, M.E., '10. 14 E. 4th St., Corning, N. Y.
CANNIFF, WILLIAM CHASE, '97. Verona, N. J.
CAPE, HENRY, JR., M.E., '13. Export Dept., Yale & Towne Mfg. Co. (2) 9 E. 40th St., New York City. (1) Holland House, New York City. (3) Care Y. & T., 9 E. 4th St., New York City.
CAPPS, WILLIAM LEE, '95. Address not known.
CAPRON, WILLIAM CARGILL, M.E., '08. (2) and (3) Care Anaconda Copper Mining Co., Anaconda, Mont. (1) 700 Main St., Anaconda, Mont.
CAPWELL, ALLISON STONE, M.E., '92. Supt. Crucible Castings Co. 712 Auburn Ave., Buffalo, N. Y.
CARD, FREDERICK AUGUSTUS, '72. Address not known.
CARD, WILLIAM DINSMOOR, '94. Fiduciary Agent, Herkimer St. (?) Pasadena, Cal.
CARDULLO, FORREST ELLWOOD, M.E., '01. Austin, Texas.
CARDEN, WILLIAM HENRY, '06. 426 Belmont Ave., Chicago, Ill.
CAREY, HERBERT WOOD, M.E., '08. Supt. of the Standard Electric Time Co. 89 Logan Ave., Springfield, Mass. (1) 926 Monmouth St., Springfield, Mass. (2) and (3) 89 Logan Ave., Springfield, Mass. A. S. M. E.
CARGILL, AUSTIN STOWELL, '12. Green Bay, Wis.
CARHART, EMORY, '09. Address not known.
CARLSON, CLARENCE DEAN, M.E., '08. 1954 East 73d St., Cleveland, O.
CARLEY, RALPH F., M.E., '07. (2) and (3) Gen'l Supt., Galesburg Ry. L. & P. Co., Galesburg, Ill.
CARLTON, WILLARD GILBERT, M.E., '92. (1) 608 Warburton Ave., Yonkers, N. Y. (2) and (3) Grand Centr. Sta., N. Y. C. R. R., New York, N. Y.
CARLISLE, GEORGE LESTER, JR., '00. New Rochelle, N. Y.
CARMAN, CHARLES WINTHROP, '97. 58 Hilton Ave., Hempstead, N. Y.
CARMAN, GLENN EVERETT, M.E., '13. (1) 45 Wakefield Ave., Buffalo, N. Y. (2) and (3) Care Pierce Arrow Motor Car Co., Buffalo, N. Y.
CARNES, FREDERICK, M.E., '08. 1005 Delaware Ave., Wilmington, Del.
CARNAGHAN, EDWIN DIXON, M.E., '87. Address not known.
CAROTHERS, J. A., '14. 146 S. Fairmount Ave., Pittsburg, Pa.
CARCLAN, EDGAR ALFRED, E.E., '92. 30 Church St., New York, N. Y.
CARPENDER, MONCURVE CONWAY, M.M.E., '05. Treasurer, Consolidated Car Heating Co. (2) and (3) 232 State St., Albany, N. Y. A. I. E. E.
CARPENDER, SYDNEY BLEECKER, M.E., '07. Vice-Pres., Gen. Mgr., Brunswick Refriger. Co. (2) and (3) New Brunswick, N. J. (1) Lindenwood, New Brunswick, N. J. Engrs. Club, A. S. R. E.
CARPENTER, CARROLL EDW., M.E., '12. Res. Engineer Internat. Paper Co. (2) and (3) Internat. Paper Co., Wilder, Vt. (1) Wilder, Vt.
CARPENTER, CHARLES AZARIAH, M.E., '08. Gen. Foreman, Camden Iron Wks., Camden, N. J.
CARPENTER, CLINTON ARTHUR, M.E., '05. (2) and (3) Care D. H. Burnham & Co., Architects. (1) 57 W. Chestnut St., Chicago, Ill. A. I. E. E., I. E. S.
CARPENTER, CHARLES KETCHUM, M.E., '07. 35 Trowbridge St., Cambridge, Mass.
CARPENTER, CLARENCE EDSON, M.E., '08. Engr., Maintenance of Way. (2) Interborough R. T. Co., 165 Broadway, New York City. (1) and (3) 2 Birch Rd., Yonkers, N. Y. A. S. C. E., A. E. R. A.
CARPENTER, GEORGE, M.E., '06. Supt. Clev. Branch, Elysia Iron & Steel Co. (2) and (3) 232 E. 131st St., Cleveland, O. (1) 1579 Crawford Rd., Cleveland, O. S. A. E.
CARPENTER, GEORGE BRIGGS, M.E., '06. Care Mrs. A. H. Smith, 200 N. Robinson St., Los Angeles, Cal.
CARPENTER, HOWARD BAYLIS, '15. Allaben, N. Y.

CARPENTER, H. B., '16. Lancaster, N. H.

CARPENTER, JOHN CONDICT, M.E., '08. Woodstock Ave., Kenilworth, Ill.

CARPENTER, J. N., JR., '14. 404 Riverside Drive, New York City.

CARPENTER, ROLLA CLINTON, M.M.E., '88. Prof. of Exp. Engrg., Cornell Univ., Ithaca, N. Y.

CARPENTER, WALTER SAMUEL, JR., '10. (2) and (3) Care Du Pont Powder Co., 484 Du Pont Bldg., Wilmington, Del. (1) 2101 Grant Ave.

CARR, EDWARD WHEELER, JR., '01. (2) and (3) 425 Gravier St., New Orleans, La. (1) 6223 Cromwell Pl., New Orleans, La.

CARR, ROBERT BIRNEY, '12. 21 Mallery Place, Wilkesbarre, Pa.

CARR, WALLACE DELAFIELD, '12. Care Zimmerman Brokerage Co., Memphis, Tenn.

CARRIER, GEORGE HURD, '01. Vice-Pres. and Sec. The Cronk & Carrier Mfg. Co. (1) 150 Lake St., Elmira, N. Y. (2) and (3) 528 W. Water St., Elmira, N. Y.

CARRIER, WILLIS HAVILAND, M.E., '01. 1350 Amherst St., Buffalo, N. Y.

CARROLL, HARRY CLARENCE, M.E., '03. Chief Engineer. (1) and (3) 2956 Princeton Place, Indianapolis, Ind. (2) Indianapolis Light and Heat Co., Indianapolis, Ind.

CARROLL, WILLIAM GILBERT, M.E., '07. 1306 Elm St., Dallas, Tex.

CARSON, CHARLES BANCROFT, M.E., '09. Construction Engr. (1) 125 Plymouth Ave., Rochester, N. Y. (2) and (3) Taylor Instrument Co., Rochester, N. Y. A. S. M. E.

CARSON, DALE BRADFORD, M.E., '12. Care Doherty & Co., 60 Wall St., New York, N. Y.

CARTER, AINSLIE TAYLOR, M.E., '10. 1716 Caton Ave., Brooklyn, N. Y.

CARTER, CHARLES EDWARD, '05. Mfgr. 642 W. 7 St., Erie, Pa.

CARTER, DONALD PERSHING, M.E., '04. 77 James St., Kingston, Penn.

CARTER, EMMETT BROWNING, M.E., '99. (2) and (3) Midvale Steel Wks., Philadelphia, Pa. (1) 7201 Greene St., Philadelphia, Pa. A. S. M. E.

CARTER, KENNETH FREELAND, '12. 121 Neperan Road, Tarrytown, N. Y.

CARTER, OWEN, '13. 403 Ross Ave., Dallas, Texas.

CARTER, WILBUR ALBERT, M.E., '13. 390 Euclid Ave., Detroit, Mich.

CARTON, JOHN BENOIST, '01. Sec.-Treas., Vanderwenter Trust Co., St. Louis, Mo.

CARVAJAL, OCTAVIO, M.E., '11. Address not known.

CARVER, HARRY E., M.E., '07. Elec. Inspector, Public Utility Co. (2) 790 Broad St., Newark, N. J. (1) and (3) 15 N. 18th St., East Orange, N. J. Am. Elect. Ry. Assn.

CARY, ERNEST BACON, M.E., '00. 149 East Ave., Lockport, N. Y.

CASABLANCA, FRANCISCO JACINTO, '11. Address not known.

CASE, A. HEBARD, '16. Student, College of Hawaii, Honolulu, H. I. Home 752 King St., Honolulu, H. I., Wailuku, Ulani, Hawaiian, I.

CASE, DONALD GRIGGS, '06. Ry. Equip. Engrg. Dept., General Electric Co., Cortland, N. Y.

CASE, FRANCES MILLS, JR., M.E., '99. 412 The Arcade, Cleveland, O.

CASE, G. HARRY, M.E., '02. (2) and (3) Chief Engr., Southwark Foundry and Machine Co., Philadelphia, Pa. (1) 82 E. Greenwood Ave., Lansdowne, Pa. A. S. M. E.

CASPER, LEROY, M.E., '05. Dining Table Mfr., Howes Cave, N. Y. Howes Cave, N. Y.

CASPER, WILLIAM LEE, A.B., '07, M.E., '08. 672 Westminster Rd., Brooklyn, N. Y.

CASTLE, SAMUEL NORTHRUP, '06 Grad. Honolulu, H. I.

CATHER, WM. ANDREWS, JR., M.E., '13. Centrifugal Pump Co., Sales Dept., (2) and (3) Henry R. Worthington Hydraulic Works, Harrison, N. J. (1) 751 Kearney Ave., Arlington, N. J.

CATLIN, WELLES GOODSPEED, M.E., '10. (2) Inst. E. E., Cornell Univ. (1) and (3) 418 Utica St., Ithaca, N. Y. A. I. E. E., S. P. E. E.

CATLIN, WILLIAM LYLE, M.E., '00. Mgr. Chattanooga Mach. Co. (2) and (3) 415 Times Bldg., Chattanooga, Tenn. (1) 608 Kirby Ave., Chattanooga, Tenn. A. S. M. E.

CAUTLEY, J. R., M.E., '06. (1) 419 West 118 St., New York City. (2) and (3) 417 Canal St., New York, N. Y. Society of Automobile Engrs.

CAVAGNARO, JOHN JOSEPH, M.E., '00. Engineer and Machinist. (2) and (3) 16 McDougal St., New York City. (1) Harrison, N. J.

CAVNAH, HOWARD EDWARD, M.E., '01. 1302 N. Market St., Canton, O.

DE CAZENOVE, LOUIS ALBERT, M.E., '02, M.M.E., '03. Consulting Engr. for the Delaware Trust Bldg. (2) and (3) I. O. O. F. Bldg., 10th and King Sts., Wilmington, Del. (1) 1616 Franklin St. A. S. M. E.

CENTER, HENRY PRICE, '93. Care J. H. Center, Ottawa, Ill.

CESSNA, JOHN RANDOLPH, M.E., '93. 140 College Ave., Ithaca, N. Y.

CHACE, PAUL GRISWOLD, M.E., '01. 115 Broadway, New York City.

CHACE, RALPH TOMKINS, M.E., '09. 510 Bird Ave., Buffalo, N. Y.

CHADOWITZ, CHARLES, '10. Address not known.

CHADWICK, JOHN CAMPBELL, '15. 116 S. 49 St., Omaha, Neb.

CHADWICK, JOSEPH JULIUS, M.E., '16. 116 S. 49th St., New York City.

CHAFFE, JOE BRYAN, JR., M.E., '12. (1) 840 Common St., New Orleans, La. (2) and (3) Alabama Power Co., Anniston, Ala.

CHALMERS, THOMAS STUART, '04. (1) Chicago Heights, Ill. (2) and (3) 115 Adams St., Chicago, Ill.

CHAMBERLAIN, FIDELIO GILLETTE, '12. Consulting Engr. (2) and (3) Tuttle Chamberlain & Co., 714 Gunter Bldg. (1) 402 August St., San Antonio, Texas. A. I. E. E.

CHAMBERLAIN, GEORGE RAY, M.E., '91. Instructor in Free Hand Drawing, Cornell University. 11 Central Ave., Ithaca, N. Y.

CHAMBERLAIN, PAUL MELLEN, M.E., '90. (2) and (3) Marquette Bldg., Chicago, Ill. (1) 427 Diversey Parkway, Chicago, Ill.

CHAMBERLAIN, ROBERT FRANKLIN, M.E., '08. Instructor Sibley College, Cornell University, Ithaca, N. Y. 7 South Ave., Ithaca, N. Y. A.I.E.E.

CHAMBERLIN, CARL STRATTON, '04. R. F. D. 2, Littleton, Colo.

CHAMBERS, FRANK ROSS, JR., M.E., '97. Farmer. (1) (2) (3) Featherstone, Prince William Co., Va.

CHAMBERS, HENRY EDWARD, JR., M.E., '11. A. M. Lockett & Co., 423 S. Pacific Bldg., Houston, Tex.

CHAMBERS, NORMAN CAMPBELL, M.E., '05. With Niles, Bement Pond Co., 111 Broadway, New York City. (1) (2) (3) Rm. 1301, 111 Broadway, New York City.

CHAMBERS, PAUL B M.E., '10. Chambers Bros. Co. (2) and (3) 52 and Media Sts., Philadelphia, Pa. (1) 6219 Jefferson St., Philadelphia, Pa.

CHAMBERS, PASCAL RALPH, M.E., '12. Local Manager, Manatee Elec. Co., Bradentown, Fla.

CHAMPAIGN, DONALD KEITH, M.E., '13. 215 Prospect St., Ithaca, N. Y.

CHAMPLIN, ERI ADDISON, M.E., '96. (2) and (3) Commission on Waterways and Public Lands, State House, Boston, Mass. (1) 10 Morgan St., Melrose Highlands, Mass. A. I. E. E.

CHAMPLIN, O. H. P., JR., '14. Strong Steel Foundry Co. (2) and (3) 33 Morris Ave., Buffalo, N. Y. (1) 24 Wellington Rd., Buffalo, N. Y.

CHANDLER, CLARENCE ANASA, '05. Address not known.

CHANDLER, DAVID HARRY, M.E., '17. Vineland, N. J.

CHANDLER, ELBERT GOODSELL, M.E., '00. 577 Telegraph Ave., Oakland, Cal.

CHANDLER, EDWARD L., '68. Address Unknown.

CHANDLER, HORACE HARRY, M.E., '05. Shoe Manufacturer. Cor. State and Landus Ave., Vineland, N. J.

CHANDLER, RICHARD EDWARD, M.M.E., '97. A. & M. College. Stillwater, Okla.

CHANDLER, WILLIAM PORTER, JR., M.E., '10. Carnegie Steel Co., Clairton, Pa.

CHANG, LAI YANG, M.E., '12. Government University of Pekin, China. (1) Y. M. C. A., Pekin, China.

CHAPIN, ARCHER LOUIS, M.E., '10. Jewelry Salesman. (2) and (3) 449 Washington St., Newark, N. J. (1) Thompsonville, Conn.

CHAPIN, ERNEST PITNEY, M.E., '93. (2) and (3) Principal Du Pont Training H. S., Brook and Oak Sts., Louisville, Ky. (1) 217 Crescent Ave., Louisville, Ky.

CHAPIN, EDWARD HALL, M.E., '89. Vice-Pres. Natl. Car Wheel Co., 556 W. 39th St., New York City.

CHAPIN, GEORGE EDWIN, M.E., '94. Distiller. (1) Malden, Mass. (2) and (3) 62 Water St., Charlestown, Mass.

CHAPIN, HARRY ALEXANDER, '15. 436 Putnam Ave., Brooklyn, N. Y.

CHAPIN, JOHN JEWITT, '90. 1804 Divine Bank Bldg., Detroit, Mich.

CHAPIN, STUART LYLE, M.E., '17. Oneida, N. Y.

CHAPMAN, CHARLES FREDERICK, M.E., '05. Editor, Motor Boating. (2) and (3) 119 W. 40th St., New York City. (1) 611 W. 152d St., New York City.

CHAPMAN, CLOYD MASON, M.E., '99. Engr. of Tests, Westinghouse Church Kerr Co. (2) and (3) 37 Wall St., New York City. (1) Douglaston, N. Y. A. S. M. E., A. S. J. M., A. C. I.

CHAPMAN, CYRIL TYLER, '15. (2) and (3) Care Ingersol Rand Co. (1) 36 Washington St., Phillipsburg, N. J.

CHAPMAN, FRANK CAREY, M.E., '07. Engr., Mfg. Automobiles. (2) and (3) Brewster & Co., Long Island City. (1) 52 Geranium St., Flushing, N. Y.

CHAPMAN, HAROLD WINCHESTER, '00. Assistant Sec. Pyrene Mfg. Co. (2) and (3) 52 Vanderbilt Ave., New York City. (1) 597 Fifth St., Brooklyn, N. Y.

CHAPMAN, HARRY LA MOTTE, M.E., '04. Green River, Utah.

CHAPMAN, ROBERT BURNS, '78. Syracuse, N. Y.

CHAPMAN, RALPH E., M.E., '11. Engr., Merritt & Chapman Derrick and Wrecking Co. (2) and (3) 17 Battery Pl., New York City. (1) 4 Tennis Court, Brooklyn, N. Y.

CHAPMAN, ROBERT HETT, M.E., '17. 172 E. Main St., Spartanburg, S. C.

CHAPMAN, WILLIAM HAROLD, M.E., '13. Conn. Fire Ins. Co., Hartford, Conn.

CHASE, ARTHUR WILLEY, M.E., '98. 302 30 St., Norfolk, Va.

CHASE, CLADD HOPKINS, M.E., '08. 325 N. Terrace, Mt. Vernon, N. Y.

CHASE, GEORGE EARLE, M.E., '14. 611 23d St., Y. M. C. A., New York City.

CHASE, HENRY FRANK, '96. 241 West 101st St., New York City.

CHASE, HERBERT, M.E., '08. (1) 48 Portsmouth Pl., Forest Hills, L. I. (2) and (3) 29 W. 39th St., New York City. Sigma Xi, Treas. and Asst. Sec. S. A. E.

CHASE, JOHN, M.E., '02. Cold Spring Harbor, N. Y.

CHASE, LYLE GLENTWORTH, '08. Address not known.

CHASE, VERNON B., M.E., '16. Y. M. C. A., Toledo, O.

CHASE, WILLIAM EDWIN, M.E., '00. 1105 1st Ave., Spokane, Wash.

CHATER, JOHN ANDREW, JR., M.E., '16. 109 Glen Place, Ithaca, N. Y.

CHATFIELD, CLARENCE EDWARD, M.E., '08. Sales Engineer, Automatic Ry. Signal Co. (2) and (3) 1575 Niagara St., Buffalo. (1) 429 Leroy Ave., Buffalo. Assoc. A. I. E. E., Assoc. Ry. Signal Assn.

CHATFIELD, HENRY WHITNEY, '97. 15 Dey St., New York, N. Y.

CHATILLON, GEORGE EDMUND, '01. 89 Cliff St., New York City.

CHATILLON, RALPH FREDERICK, M.E., '01. 89 Cliff St., New York, N. Y.

CHEN, TAO YUAN, M.E., '09. 15 Pekin Rd., T. C. Sun, Shanghai, China.

CHEN, YE TSAU, M.E., '14. Tsinghua College, Pekin, China. Care H. J. Fei.

CHENEY, ROLLIN KIMBALL, M.E., '03. General Supt., Sweets Steel Co. (1) (2) (3) 811 Market St., Williamsport, Pa. Am. Iron & Steel Inst.

CHESNEY, M. M., M.E., '16. 74 Dawes Ave., Pittsfield, Mass.

CHEW, JOHN JAMES, 2D, '15. 392 E. Washington Ave., Bridgeport, Conn.

CHEYNEY, CHARLES CROWELL, M.E., '11. 2517 Lincoln St., Evansville, Ill.

CHILCOTE, LAWRENCE REED, M.E., '16. 2619 Ashby Ave., Berkeley, Cal.

CHILDS, JOHN NORRIS, M.E., '10. Mfg. International Steam Pump Co. (2) and (3) 510 Mills Bldg., El Paso, Texas. (1) 1138 Nevada St., ElPaso, Texas.

CHILDS, LYSANDER D., M.E., '06. 65 Park Ave., New York City.

CHILDS, WALLACE JONES, M.E., '01. Sales Agent. 96 Cornelia St., Utica, N. Y. 48 Liberty St., Utica, N. Y.

CHILTON, ST. JOHN POINDEXTER, '97. Address not known.

CHIN, WEI YUNG, M.E., '16. (1) Shanghai, China. (3) 107 Cook St., Ithaca, N. Y.

CHIPMAN, CHARLES EDGAR, M.E., '96. 325 Pearl St., New York City.

CISNEROS, ANIBAL, '08. Address not known.

CHOATE, EDWARD STEPHEN, M.E., '03. Farmer. Roslyn, Md.

CHOATE, RICHARD PEARRE, '08. Roslyn, Md.

CHOW, JEN, M.M.E., '15. 34 Chang-Su-Lee, Park Road, Shanghai, China.

CHRISTENSEN, RUDOLPH, JR., '10. 303 Sterling Place, Brooklyn, N. Y.

CHRISTESEN, CHARLES JOHN, M.E., '14. Cocoanut Grove, Dade Co., Fla.

CHRISTIE, ALEXANDER GRAHAN, '09. Univ. of Wisc., Madison, Wis.

CHRISTY, WILLIAM GASTON, M.E., '11. Engr. for Fitzgerald, Grenfell & Co. (2) and (3) 1103 Boatmen's Bank Building, St. Louis, Mo. (1) 3641 Lindell Boulevard, St. Louis, Mo.

CHRYSSIDES, STAVROES STEPHEN, '09. R. H. B. S. Kilkis. Ministere de la Marine, Athens, Greece.

CHU, PAO FENG, M.E., '09. Care H. Sen, 15 Peking Rd., Shanghai, China.

CHUBAROFF, CERGEY, '78. Address not known.

CHUN, FU SHI, M.E., '14. 123 Loochow St., Foochow, China.

CHURCH, ALFRED WHITING, '01. 1743 Broadway, New York City.

CHURCH, EDGAR DAMON, '89. (2) and (3) Treas. Buick Co., Moline, Ill. (1) 321 N. Hamilton St., Saginaw, Mich.

CHURCH, EDWIN FAYETTE, B.M.E., '76. 303 W. Church St., Elmira, N. Y.

CHURCH, FRANK LEONARD, '92. Citrus Culture. Cocoanut Grove, Fla.

CHURCH, JOHN JAMES, '79. Care F. W. H. Church, Aylmer, Canada.

CHURCH, LLOYD MAYNARD, M.E., '13. Care The Automatic Refrigerating Co., Hartford, Conn.

CHURCH, WILMER, M.E., '85. Constructing Engineer. (1) 156 Mansion St., Poughkeepsie, N.Y.

CHUTE, STANLEY, JAMES, M.E., '13. Inspector Grand Central. (2) and (3) G. C. T. Service Plant, 112 E. 50th St., New York City. (1) 1140 President St., Brooklyn, N. Y. A. S. M. E.

CISIN, HARRY GEORGE, M.E., '14. 378 E. 7th St., Brooklyn, N. Y.

CLAFLIN, LEON RALPH, M.E., '10. 580 Boulevard E., Weehauken, N. J.

CLANCY, WILLIAM CLARENCE, M.E., '13. 4530 Woodlawn Ave., Chicago, Ill.

CLAPP, RAYMOND FURBUSH, '10. De Beque, Colo.

CLAPP, RUEL FREDERICK, JR., '10. 70 N. Pearl St., Albany, N. Y.

CLARK, ANSON LUMAN, '14. 106 Spring St., Elgin, Ill.

CLARK, CHARLES PAUL, M.E., '11. Wellsville, N. Y.

CLARK, CLIFFORD, M.E., '08. Commercial Eng. (2) and (3) Marine Sales Dept. G. E. Co., Schenectady, N. Y. (1) 785 State St., Schenectady, N. Y.

CLARK, DAVID, M.E., '98. Managing Editor Southern Textile Bulletin. 912 Independence Bldg., Charlotte, N. C. Charlotte, N. C.

CLARK, Dean, M.E., '98, M.M.E., '99. Box 156, 727 W. Washington Ave., South Bend, Ind.

CLARK, Edward Everett, M.E., '92. Director of Trades School. 722 W. Gray St., Elmira, N. Y.

CLARK, Edward H., M.E., '09. Bus. Mgr., Cortland Standard Printing Co. (2) and (3) 110 Main St., Cortland, N. Y. (1) 31 Prospect St., Cortland, N. Y.

CLARK, Edwin, M.E., '11. 72 State St., Ogdensburg, N. Y.

CLARK, Edwin Carleton, M.E., '94. 1133 Union Oil Bldg., Los Angeles, Cal.

CLARK, Eugene Bradley, M.E., '94. Vice-Pres. American Sintering Co. 631 Ry. Exch., Chicago, Ill.

CLARK, Farley Granger, '95. Chief Engineer, Toronto Power Co. 12 Adelaide St., Toronto, Can.

CLARK, Frank Durbon, M.E., '02. Box 567, Hicksville, L. I., N. Y.

CLARK, Frederick Ira, '98. 602 Wilson Bldg., Dallas, Tex.

CLARK, George Donald, '95. Merchant, Grand Forks, British Columbia.

CLARK, Harold Haynes, M.E., '00. Local Mgr., Sink-Belt Co. (1) 1130 Milan Ave., S. Pasadena, Cal. (2) and (3) 161-3 N. Los Angeles St. Los Angeles, Cal.

CLARK, Harold Howard, '15. Instructor Sibley College, Cornell Univ. 132 University Ave., Ithaca, N. Y.

CLARK, Harry DeWitt, M.E., '09. Y. M. C. A., Jackson, Mich.

CLARK, Harry Josiah, M.E., '95. 107 W. Borden Ave., Syracuse, N. Y.

CLARK, John Arvine, M.E., '10. 220 Meigs Ave., Clarksburg, W. Va.

CLARK, John O'Fallon, jr., M.E., '03. 1850 McCormick Bldg., Chicago, Ill.

CLARK, Lewis Harold, '00. 1003 N. 2d St., Rockford, Ill.

CLARK, Lyle Hamilton, '14. 193 Michigan Ave., Chicago, Ill.

CLARK, Melville N., '12. Clarks Mills, Me.

CLARK, Merrell Edward, M.E., '11. Patent Lawyer. (2) and (3) 52 William St., New York City. (1) 231 Sanford Ave., Flushing, N. Y.

CLARK, Montgomery Hunt, '99. 62 W. 68th St., New York City.

CLARK, Oliver R., A.B., '12. Farmington, Utah.

CLARK, Roy Edwards, '13. Box 427, Norwood, N. Y.

CLARK, William A. G., M.E., '00. Commercial Agent, U. S. Dept. of Commerce. (2) and (3) 1801 Customhouse, Boston, Mass. (1) 1805 Beacon St., Brookline, Mass.

CLARK, William V. A., M.E., '09. Matawan, N. J.

CLARKE, Charles Frederick, '16. 1325 Astor St., Chicago, Ill.

CLARKE, Edgar Whitney, M.E., '05. Address not known.

CLARKE, Herbert Burns, M.E., '91. Huasteca Petroleum Co., Tampico, Mexico.

CLARKE, Milo Robinson, M.E., '03. Address not known.

CLARKE, Philip Lancaster, '07. Address not known.

CLARKE, Van Allen S., M.E., '08. Natl. Carbon Co. 1841 W. 117 St., Cleveland, O.

CLARKE, William Addison, '92. Lumber business. 1638 Broadway, Toledo, O.

CLAUSE, Robert Lewis, M.E., '14. Pittsburgh Plate Glass Co., Ford City, Pa.

CLAVELL, Jorge, '12. Box 13, Ponce, Porto Rico.

CLAY, Terry Pitkin, '10. Station H, Cleveland, Ohio.

CLAYTON, W. F., M.E., '14. (1) 235 Portage Ave., Three Rivers, Mich. (2) and (3) Sheffield Car Co., Three Rivers, Mich.

CLEAVER, Charles Alfred, '94. Texas Mgr., Contractor's Supplies, Thalian Club, Houston, Texas.

CLEMENS, Abraham Bowman, M.E., '92. Principal, Sch. of M.E., Director, International Corres. Schools, Scranton, Pa. 1034 Woodlawn St., Scranton, Pa. A. S. M. E.

CLEMINSHAW, R. H., M.E., '16. Cleveland Metal Products Co., Cleveland, Ohio. 1918 E. 70th St., Cleveland, O.

CLEMSON, John Gardner, '03. Real Estate Mines and Investments, 714 Chamber of Commerce, Portland, Ore.

CLEPHANE, Lewis Painter, M.E., '92. Landscape and Marine Painter. (2) and (3) 1110 F. St., N. W., Washington, D. C. (1) 1225 K St., N. W. Washington, D. C.

CLEPHANE, Malcolm Wolcott, M.E., '93. 45 Broadway, New York, N. Y.

CLEVELAND, Charles Elmer, '11. 569 E. 59th St., Portland, Ore.

CLEVELAND, Fred P., M.E., '06. Sec. and Treas., B. F. Perkins & Son, Inc. (2) and (3) 2 Crescent St., Holyoke, Mass. (1) 62 Taylor St., Holyoke, Mass. A. S. M. E.

CLEVELAND, Harry Whitehill, '08. 64 Grand St., Newburgh, N. Y.

CLEVELAND, John Augustus, M.E., '04. Care Hodenpyl, Hardy & Co. 14 Wall St., New York City.

CLOCK, Fred Adam, M.E., '09. Clockville, Madison Co., N. Y.

CLAFLIN, Wilbur Adelbert, '10. Address not known.

CLORAN, Glendyn Lionel, '13. Care James B. Brady, 7 W. 86th St., New York City.

CLOSE, Henry Breevort, '05. Close & Buoron Co., Ltd. South Fort George, B. C., Canada.

CLOSE, John Campbell, M.E., '05. 217 Clarence St., Sidney, Australia.

CLOSE, Ralph Tompkins, M.E., '94. Engr. in charge, Westinghouse, Church, Kerr & Co. (2) and (3) 37 Wall St., New York City. (1) Westwood, N. J.

CLOUGH, Waltes William, '13. Locomotive Fireman, Del. & Hudson Co. (1) (2) (3) 234 Main St., Oneonta, N. Y.

CLOYES, Raymond T., M.E., '10. Automobile Salesman. (2) and (3) 6604 Euclid Ave., Cleveland, O. (1) 13909 Shaw Place, Cleveland, O.

CLUTE, Charles Anthon, '89. West Milton, N. Y.

CLYDE, William Michel, '97. Address not known.

CLYNES, Bernard Louis, M.E., '13. 526 W. Seneca St., Ithaca, N. Y.

COALE, Harvey Morton, M.E., '04. Cynwood, Pa.

COATES, Henry T., M.E., '00. Asst. Engr. of Motive Power. (2) and (3) Penn. R. R., Broad St. Station, Philadelphia, Pa. (1) 131 Poplar Ave., Wayne, Pa.

COBB, Harry Elmore, M.E., '15. Engr. Dept. Production Control. (2) Remington Arms and Ammunition Co., Bridgeport, Conn. (1) Audubon, N. J. (3) 704 Kossuth St., Bridgeport, Conn. A. S. M. E., A. I. E. E.

COBLE, Adlai Stevenson, M.E., '15. 14 Rochelle Place, New Rochelle, N. Y.

COBLEIGH, Henry Rice, M.E., '01. 503 E. 8 St., Brooklyn, N. Y.

COCHRAN, Joseph Haney, '15. 320 W. 18th St., Little Rock, Ark.

COCHRAN, Samuel Adams, M.E., '09. (2) and (3) Care Nowlin Lumber Co. Moore & Turner Bldg., Little Rock, Ark. (1) Pine and Clinton Sts., Pulaski Hts., Ark.

COCHRANE, Harry Hamilton, M.M.E., '06. (2) and (3) Elect. Engr., Montana Power Co., Butte, Montana. (1) 1023 Diamond St., Butte, Mont. A. I. E. E.

COCHRANE, Hayward, M.E., '90. Elect. Engr. (1) (2) (3) Antrim, N.H.

COCKRILL, Emmett, M.E., '06. 332 Clinton St., Brooklyn, N. Y.

COE, Benjamin Steele, '06. 1555-65 R. R. Ave., Bridgeport, Conn.

COFFEY, Harry T., '04. Address not known.

COFFIN, Grange Simon, jr., M.E., '12. Care Remington Arms Co., 1025 Nobe Ave., Bridgeport, Conn.

COFFIN, Charles William Floyd, '12. (1) 200 N. Central Ave., Austin, Chicago, Ill.

COFFIN, Harry Randolph, M.E., '08. 11 Fairwood Rd., Madison, N. J.

COFFIN, William Hallock, '06. 3439 Lafayette Ave., St. Louis, Mo.

COFFIN, William Jay, M.E., '98. 571 Myrtle Ave., Albany, N. Y.

COGGESHALL, Clayton Smiley, M.E., '11. Turbine Sales Dept. (2) and (3) Gen. Elec. Co., Schenectady, N. Y. (1) 317 Glenwood Bvd. A. I. E. E.

COHEN, Douglas Hart, '98. Address not known.

COHEN, Emanuel M., M.E., '17. 445 Pulaski St., Brooklyn, N. Y.

COHEN, Morton, M.E., '08. 5205 3d Ave., Brooklyn, N. Y.

COHN, Benjamin, '14. 296 Main St., Orange, N. J.

COHN, Mathias Alvin, '11. (2) and (3) Care H. W. Johns-Manville Co., Mgr., Little Rock Aff., 100-1 City Market and Arcade Bldg., Little Rock, Ark. (1) 902 W. 3d St., Little Rock, Ark.

COIMBRA, Anastacio Rodriques de Aquino, '84. Trex Ilhos, Rio de Janeiro, S. A.

COIT, William Hersee, '13. 33 Linwood Ave., Buffalo, N. Y.

COLDWELL, Orin B., M.E., '02. 504 Spring St., Portland, Ore.

COLE, Clifford Comstock, '07. Address not known.

COLE, Clarence Myron, '06. Care Myron M. Cole. Clear Lake, Wash.

COLE, Dale Stevens, M.M.E., '12. 11503 Mayfield Rd., Cleveland, O.

COLE, Edward Smith, M.E., '94. Hydraulic Engr. and Pres. Pitometer Co. (2) and (3) 25 Elm St., New York City. (1) 133 Bellevue Ave., Upper Montclair, N. J. A. S. M. E., A. S. C. E.

COLE, Frank Barto, '84. 79 E. Broad St., Newman, Ga.

COLE, George Willard, '80. 225 Rudderow Ave., Merchantville, N. J.

COLE, Harold, M.E., '16. 217 West Ave., Ithaca, N. Y. A. I. E. E.

COLE, Ira Earl, M.E., '15. Development Engr. in Physical Lab., Dept. 695. (2) and (3) Western Elec. Co., 463 West St., New York City. (1) 220 Williams St., Elmira, N. Y. A. I. E. E.

COLEMAN, Eugene Hunter, M.E., '12. Consulting Engr., J. F. Coleman Engrg. Co. Home 1824 Octavia St., New Orleans, La.

COLEMAN, George Kadel, M.E., '17. Westville, N. J.

COLEMAN, Joseph Emile, M.E., '02. 15 Rector Pl., Red Bank, N. J.

COLEMAN, Richard Reid, '12. 1978 E. 70th St., Cleveland, Ohio.

COLER, Carl S., M.E., '11. Mgr., Casine Technical Night School. (2) and (3) Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa. (1) 404 Biddle Ave., Wilkinsburg, Pa.

COLGATE, George Marc, M.E., '10. 1589 Mound St., Springfield, Ohio.

COLIN, Theodore Frederick, '87. Address not known.

COLINA, Benito, '14. Seclantas, Salta, Arg. Rep.

COLLIER, George Dudley, '05. 680 Clinton St., Rochester, N. Y.

COLLIER, Lamar Sheffield, M.E., '06. 252 W. Peachtree St., Atlanta, Ga.

COLLIER, Otto Lindsay, '03. 15 Church St., Uniontown, Pa.

COLLIN, John Bernhard, '07. 1111 15 Ave., Altoona, Pa.

COLLINS, Frederick Arthur, M.E., '15. 98 Central Ave., Flushing, N. Y.

COLLINS, Willis G., M.E., '95. Pres., Gen. Mgr., Milwaukee Separator Mfg. Co. (1) 1320 Grand Ave., Milwaukee, Wis. (2) and (3) 247 Madison St., Milwaukee, Wis.

COLLINS, Gilbert Lafayette, '12. 5 S. Brighton Ave., Atlantic City, N. J.

COLLINS, Harry Llewellyn, M.E., '95. (1) 327 Hillside Ave., Jamaica, N. Y. Municipal Bldg., Brooklyn, N. Y.

COLLINS, Lyman Pelton, '15. Greenwich St., Hempstead, N. Y.

COLLINS, Roderick Greene, jr., '93. Address not known.

COLLINS, Samuel Wilson, M.E., '13. Oil Drilling Contractor. (1) 1709 S. Carson Ave., Tulsa, Okla. (2) and (3) Box 811, Tulsa, Okla.

COLLYER, William Curtis, '15. 1842 Wesley Ave., Evanston, Ill.

COLLYER, John Lyon, M.E., '17. Chelsea-on-Hudson, N. Y.

COLPITTS, James Vandever, '09. (1) R. F. D. 3, Newton Square, Pa.

COLPOYS, Lewis Howard, '15. Home 2113 Main St., Niagara Falls, N. Y.

COLT, Samuel Gilbert, M.E., '95. Pres., Richmond Iron Wks. 76 E. Housatonic St., Pittsfield, Mass.

COLT, William Leonard, M.E., '94. Pres. Colt-Stratton Co. (1) Bronxville, N. Y. (2) and (3) Broadway and 58th St., New York, N. Y. S. A. E.

COLTON, Gordon Weir, M.E., '01. (1) 196 Berkeley Place, Brooklyn, N. Y. (2) and (3) 30 E. 42 St., New York, N. Y.

COMFORT, George, M.E., '07. (2) and (3) Care Trowbridge & Livingston (Archs.), 527 Fifth Ave., New York City. (1) 514 W. 114th St., New York City.

COMFORT, Newman, '13. Mgr. Universal Inspection Co. of Iowa. (1) 3319 Cunning St. (2) and (3) 445 Brandeis Bldg., Omaha, Neb. A. S. M. E.

COMFORT, Stewart Suffern, '98. Stock Farmer. R. F. D. 2, Elmira, N. Y.

COMINS, Harold Northend, M.E., '10. Instructor in M.E., Engr. Bldg., University of Penn., Philadelphia, Pa. 3905 Walnut St., Philadelphia, Pa.

COMPTON, Ralph Osgood, M.E., '17. 815 St. John's Place, Brooklyn, N. Y. Eta Kappa Nu.

COMSTOCK, D. R. Gage, N. Y.

COMSTOCK, Jay Floyd, M.E., '06. 6 Torion Ave., Worcester, Mass.

COMSTOCK, Philip Sidney, '11. Address not known.

CONANT, Harold Abbott Rand, '15. 22 Norman Rd., Upper Montclair, N. J.

CONANT, Ralph Waldo, '09. (1) 6 Fair Oaks Ave., Newtonville, Mass. (2) and (3) 184 Summer St., Boston, Mass.

CONARD, Charles, M.E., '96. Navy Yard, Portsmouth, N. H.

CONEN, John Joseph, jr., M.E., '07. 1059 W. Fayette St., Baltimore, Md.

CONFER, Francis John Frederick, '98. 6-7 Nicholson Bldg., Altoona, Pa.

CONGDON, Clem H., M.E., '16. Philadelphia, Pa. A. I. E. E.

CONKLIN, Arthur Stewart, '95. Major, U. S. Army, Washington, D. C.

CONKLIN, Harry Raymond, M.E., '92. (1) (2) (3) Joplin, Mo. A.S.M.E.

CONLEE, George D., M.M.E., '08. Supt. Chuctanunda Gas & Light Co. (2) and (3) 33 Market St., Amsterdam, N. Y. (1) 20 Grant Ave., Amsterdam, N. Y. Sigma Xi, A. S. M. E.

CONNELL, Hooper Phillips, M.E., '11. 2001 Grand Ave., Nashville, Tenn.

CONNELL, John Joseph, '97. 13 Park Row, New York City.

CONNOR, Cornelius Michael, jr., M.E., '11. Addison, N. Y.

CONNOR, Frank Darrow, M.E., '96. Care W. R. Hunt & Co. 90 West St., New York City.

CONOVER, Hugh Bedle, M.E., '07. Supt. Elec. Dept., Carnegie Steel Co. (2) and (3) Mingo Junction, Ohio. (1) 1446 W. Market St., Steubenville, O.

CONOVER, James MacDonough, 2d, '11. Address not known.

CONSTAM, Alyn Frank, M.E., '13. Association Bldg., Flint, Mich.

CONSTAM, E. 419 Lauraen St., Baltimore, Md.

COOK, Charles Lewis, M.E., '15. Painted Post, N. Y.

COOK, Charles Reed, M.E., '07. Paint Mfg., 2107 Broadway, Kansas City, Mo. 808 E. Armour Blvd., Kansas City, Mo.

COOK, Fayette Andrus, M.E., '08. Atlantic Gulf & Pacific Co. (2) and (3) 2405 Park Row Bldg., New York City. (1) 75 Pineapple St., Brooklyn, N. Y. Amer. Soc. Naval Engrs.

COOK, John Ames, '93. 1833 Riverside Ave., Marinette, Wis.

COOK, Junius Ford, M.E., '93. 179 Jubilee Rd., Parkstown, Johannesburg, S. Africa.

COOK, GEORGE FREDERIC, '94. 2222 6 St., N. W., Washington, D. C.

COOK, JOSEPH ANSEL, M.E., '15. Teacher Math. Mech. Draw., and Manual Train., High School. (2) and (3) Dunkirk, N. Y. (1) 713 Deer St., Dunkirk, N. Y.

COOK, RALPH VICTOR, M.E., '98. 2224 Druid Hill Ave., Baltimore, Md.

COOK, STANLEY WARD, M.E., '10. Patent Attorney. (2) and (3) 1647 Monadnock Bldg., Chicago, Ill. (1) 5211 Cornell Ave.

COOK, WILLIAM L., M.E., '00. Distr. Mgr., New York Tel. Co. (2) and (3) 8 Erie St., Jersey City, N. J. (1) 201 Harrison Ave., Westfield, N. J.

COOKE, ALEXANDER HAMILTON, M.E., '98. 201 W. 87 th St., New York City.

COOKE, DONALD DUNLOP, '15. 384 Broadway, Paterson, N. J.

COOKE, EVERETT BROWNELL, M.E., '17. Arcola, C. C., Ridgewood, N. J.

COOKE, FRANK LESLIE, '95. Hackettstown, N. J.

COOL, FRANK WARREN, M.E., '00. 221 Wyoming Ave., Pittston, Pa.

COOLBAUGH, RONALD GILBERT, M.E., '03. (2) and (3) Engineer, Campbell Soup Co., Camden, N. J. (1) 2 W. Walnut Ave., Merchantville, N. J.

COOLEY, ERWIN STRATTON, M.E., '99. 52 Vanderbilt Ave., New York City. 266 Willow St., New Haven, Conn.

COOLEY, MAXWELL S., M.E., '96. Engr., Hutchison Vapor Heating Corporation. (2) and (3) 246 Woodward Bldg., Washington, D. C. (1) 121 "W" St., N. W., Washington, D. C. A. S. H. V. E.

COON, JOHN SAYLER, B.M.E., '77. Georgia School of Tech., Atlanta, Ga.

COONS, PERRY TOWNSEND, M.E., '09. (1) 4 Hawthorne Pl., Montclair, N. J. (2) and (3) Am. Steel & Wire Co., Montclair, N. J.

COOPER, CHARLES JAMES, JR., '10. Address not known.

COOPER, FRANCIS TITUS, M.E., '11. 5437 Penn. Ave., Pittsburgh, Pa.

COOPER, HARRY REGINALD, '04. 1312½ Commerce St., Dallas, Texas.

COOPER, JOHN VANDERVEER, '96. Curate, St. Paul's Church. (2) Flatbush, Brooklyn, N. Y. (1) and (3) 63 Clarkson St., Brooklyn, N. Y.

COOPER, LE BRUN, '05. 122 Prospect St., East Orange, N. J.

COOPER, RALPH STUART, M.E., '03. 170 Broadway, New York, N. Y.

COOPER, RAY SIMEON, '13. Wolcott, N. Y.

COOPER, ROBERT J., M.E., '08. Mgr. R. J. Cooper Co. (2) and (3) 320 Kearns Bldg., Salt Lake City, Utah. (1) University Club, Salt Lake City, Utah.

COOPER, WILLIAM, '88. Address not known.

COPELAND, CLEMENT AUSTIN, M.E., '96. (1) 4701 Grant St., Los Angeles, Cal. (2) and (3) 645 South Olive St., Los Angeles, Cal. A. I. E. E. Sigma Xi.

COPELAND, WALTER GORDON, M.E., '10. Box 146, Glencoe, Ill.

CORBETT, LEWIS ALBERT, '11. Huntsville, Wash.

CORBOY, WILLIAM JOSEPH, '13. 2008–122 S. Michigan Ave., Chicago, Ill.

CORCORAN, EDWARD STEPHEN, M.E., '17. (1) Interlaken, Mass. (2) Kelly-Springfield Motor Truck Co., Springfield, O. (3) 267 S. Clairmont Ave., Springfield, O.

COREY, FRED B., M.E., '92. Consulting Engr. (2) and (3) 404 Arrott Bldg., Pittsburgh, Pa. (1) 245 Maple Ave., Edgewood Park, Pittsburg, Pa. A. S. M. E., A. I. E. E., A. A. A. S.

CORLISS, LOUIS FISK, M.E., '17. 1412 Sterling Place, Brooklyn, N. Y. Eta Kappa Nu.

CORNELL, ARTHUR WAKEFIELD, '11. Box 108, Western Springs, Ill.

CORNELL, CHANNING BRISTOL, '96. Lawyer, Merchant Exchange. San Francisco, Cal.

CORNELL, CHARLES LORIN, M.E., '89. Care Niles-Bement Pond Co. (1) 259 Tremont Ave., Orange, N. J. (2) and (3) 111 Broadway, New York, N. Y.

CORNELL, CHARLES WALTER, JR., M.E., '08. Birmingham Garage Co., Birmingham, Ala.

CORNELL, JOHN BEELER, JR., '92. 111 Broadway, New York City.

CORNELL, RAY WESLEY, '13. 384 Eastern Ave., Grand Rapids, Mich.

CORNELL, RODMAN MUNN, M.E., '09. Care Stand. Undergr. Cable Co., Pittsburg, Pa.

CORNELL, WILLIAM BOUCK, M.E., '07. 2 Riverside Dr., Niagara Falls, N. Y.

CORNELL, WILLIS RAYMOND, '13. 654 E. 62d North St., Portland, Ore.

CORNISH, GEORGE ALONZO, '93. Farmer. Gillette, N. Y.

CORNWELL, EUGENE WILLARD KLINE, M.E., '15. Care Keystone Forging Co. (1) 236 Water St., Northumberland, Pa.

CORNWELL, HOBART VALENTINE, M.E., '13. 152 Greenwich St., Hempstead, L. I., N. Y.

CORRELL, HUGH, '07. Canton, O.

CORSE, VIRGIL POWERS, '95. Lacona, N. Y.

CORTELYOU, CHARLES METCALF, '06. West New Brighton, N. Y.

CORTI, JULIS JOSE, '11. Calle, Belgrano, Mendoza, Arg. Rep.

CORWIN, C. D., M.E., '16. Groton, N. Y.

CORWIN, CHAS. DUDLEY, M.E., '08. Instructor Machine Design. (2) and (3) 307 Eddy St., Ithaca, N. Y. (1) 15 Union St., Cortland, N. Y. Sigma Xi.

CORWITH, HOWARD POST, M.E., '16. (1) Water Mill, Long Island, N. Y. (2) and (3) 237 St. James Place, Brooklyn, N. Y. A. I. E. E.

CORY, CLARENCE LINUS, M.M.E., '91. Univ of Cal., M.E. Dept. Berkeley, Cal. 2227 College Ave.

CORY, FRED CLAIR, M.E., '13. The Cory Mfg. Co., Toledo, O. (1) 957 N. Union St., Fostoria, O.

CORY, HARRY THOMAS, M.M.E., '96. Consulting Engr. (2) and (3) 702 Nevada Bk. Bldg., San Francisco, Cal. (1) 835 Hyde St., San Francisco, Cal. A. M., Soc. C. E., Am. Soc. M. E.

COSBY, FRANK CLARK, M.E., '93. Mgr., N. E. Sales Dept., Stand. Underground Cable Co. (2) and (3) 10 Post Office Square, Boston, Mass. (1) 30 Englewood Ave., Brookline, Mass.

COSGROVE, WILLIAM HUGH, M.E., '15. 447 Second St., Braddock, Pa.

COSTELLO, GEORGE JUSTIN, M.E., '03. Bethlehem Steel Co., Bethlehem, Pa.

COSTELLO, JAMES HARRY, '06. 551 E. Water St., Elmira, N. Y.

COTA, ALEJANDRO R., M.E., '16. (2) and (3) Care Telluride Ass., Provo, Utah. (1) Fuerte, Sinaloa, Mexico. Eta Kappa Nu, Tau Beta Pi.

COTHRAN, JAMES SPROULL, JR., M.E., '93. Box 965, Charlotte, N. C.

COTTLE, ARTHUR PRESTON, M.E., '07. Sheffield Car Co., Three Rivers, Mich.

COTTRELL, BENJAMIN STANTON, M.E., '97. Newport, R. I.

COTTRELL, LEON WILLIAM, M.E., '01. (1) 55 Kelby St., Boston, Mass. (2) and (3) 147 Milk St., Boston, Mass.

COUCH, ALGER DANIEL, M.E., '13. (2) Care Hercules Powder Co., Kenvil, N. J. (1) and (3) Hotel Dover, Dover, N. J.

COUCH, GEORGE JAMES, LL.B., '08. Lawyer, Aqueduct Bldg., Rochester, N. Y.

COUCH, WILLIAM ROBERT, M.E., '02. Care The Bishop, Babcock Becker Co. 439 Lafayette St., New York, N. Y.

COUGHLIN, JAMES MARTIN, JR., M.E., '08. Care B. G. Carpenter & Co. Wilkes-Barre, Pa.

COUGHLIN, SAMUEL BRITTON, '01. 315 Wood St., Burlington, N. J.

COULTER, WILLIAM ADAMS, M.E., '17. (1) and (3) 143 Maplewood Ave., Bridgeport, Conn. (2) Raymond Concrete Pile Co.

COURSEN, EDGAR G., JR., Sp. '11. 701 Madison Ave., Scranton, Pa. (2) and (3) 322–4 Adams Ave., Scranton, Pa.

COURSEN, RONALD CHESTER, M.E., '17. (1) Salisbury, Md. (2) and (3) 1826 S. Logan Square, Philadelphia, Pa.

COVELL, GRANT ADELBERT, M.E., '87. Corvallis, Ore.

COWAN, FREEMAN BRITTON, M.E., '91. Mgr. Drop Forging Dept. Steel Co. of Canada. (1) (2) (3) Gananoque, Ont. A. D. F. A.

COWAN, WAYNE WEEKS, M.E., '15. 1165 W. Water St., Elmira, N. Y.

COWARD, HERBERT, M.E., '01. 107 Claremont Ave., Buffalo, N. Y.

COWARD, OSMUND LATROBE, '08. Citadel, Charleston, S. C.

COWDIN, THOMAS HILL, M.E., '00. Silver Creek, N. Y.

COWING, H. L., M.E., '00. Asst. Librarian. (1) 201 Mansfield St., New Haven, Conn. (2) Free Public Library, New Haven, Conn.

COWLES, E., M.E., '16. 2612 Prospect St., Cleveland, O.

COWLES, JOSEPH W., M.E., '90. Supt. Installation Dept. (2) and (3) 39 Boylston St., Boston, Mass. (1) 131 Thorndike St., Brookline, Mass. A. I. E. E., N. E. L. A., I. E. S., Edison Ass.

COWLES, WALTER MILLER, '13. 412 N. Church St., Charlotte, N. C.

COWPERTHWAIT, ALLAN, M.E., '94. (2) Care A. B. See Elevator Co. (1) Hydewood Park, Plainfield, N. J. 220 Broadway, New York City.

COX, CHRISTOPHER PAUL, M.E., '08. Temp. 910 S. Michigan Ave., Chicago Ill. Perm. Wash. Country Club, Washington, D. C.

COX, JAMES WILLIAM, JR., M.E., '09. (1) 3 Elk St., Albany, N. Y. (2) and (3) Care Albany Felt Co., Albany, N. Y.

COX, RICHARD MENDENHALL, '16. 582 North St., Plymouth, Va. (3) Box 751, Plymouth, Va.

COX, THOMAS RIGGS, M.E., '11. (2) and (3) Sec. Albany Felt Co., Albany, N. Y. (1) 17 North Hawk St., Albany, N. Y.

COYLE, DICKSON KEARNS, '09. (2) and (3) P. & L. E. Station, General Manager's Office, Pittsburg, Pa. (1) 149 Dithridge St.

CRAFT, WARREN MOORE, M.M.E., '94. Rm. 1406, 15 Dey St., New York City.

CRAFTS, CURTIS S., M.E., '16. 51 N. Central Ave., Chicago, Ill.

CRAIG, IRA LYNN, M.E., '08. Asst. Elec. Engr., Amer. Gas Co., 7th and Locust Sts. (2) and (3) 712 Locust St., Philadelphia, Pa. A. I. E. E.

CRAIG, JOHN FARRELL, '12. (2) and (3) Care Westinghouse Airbrake Co., Pittsburgh, Pa. (1) 7 Trenton Ave., Edgewood, Pittsburg, Pa.

CRAIG, SAM NESBIT, '06. (2) Care Treadwell Construction Co., Midland, Pa. (1) and (3) 409 Sharon Rd., Beaver, Pa.

CRAIG, THOMAS LUTHER, '95. Address not known.

CRAIG, THOMAS ROBINSON, M.E., '15. Mgr. George Craig & Sons, Lumber Mills. (2) and (3) Winterburn, W. Va. (1) Rosemont, Pa.

CRAIG, WILLIAM DAVID, M.E., '10. Res. Engr. in charge Constr. work. (1) 1505 McGee Ave., Berkeley, Cal. (2) and (3) Care Giant Powder Co., Giant, Cal.

CRAIGHEAD, JAMES RAY, M.E., '06. 39 Hough Ave., Schenectady, N. Y.

CRAIN, JOHN JAY, M.E., '96. Wallingford, Conn.

CRAIN, L. D., M.M.E., '02. Box 513, 117 Linden St., Fort Collins, Col.

CRANDALL, ADDISON BARDSHAW, M.E., '17. Signal Service with Western Union Tel. Co., Ithaca, N. Y. A. I. E. E.

CRANER, HARRY NICHOLAS, M.E., '02. 507 Stinard Ave., Syracuse, N. Y.

CRANKSHAW, JAMES BLISS, '92. (1) 3128 Fairfield Ave., Fort Wayne, Ind.

CRAWFORD, GILBERT H., JR., M.E., '10. Asst. Chief Engr. De La Vergne Mach. Co. (3) and (1) 272 Hicks St., Brooklyn, N. Y. (2) Foot East 138th St., New York City. Amer. Soc. of Refrigerating Engineers. A. S. R. E.

CRAWFORD, JAMES DALE, M.E., '08. (1) and (2) 307 Oakland Ave., Pittsburg, Pa. (3) Cambria Steel Co., Johnstown, Pa.

CRAWFORD, JOHN GORHAM, M.E., '01. Fuel Engr. C. B. & O. R. R. Co. (2) and (3) 547 W. Jackson Blvd., Chicago. (1) 5701 Ingleside Ave., Chicago, Ill.

CRAWFORD, THOMAS FREW, M.E., '05. 6240 Chestnut St., Philadelphia, Pa.

CRAZE, GEORGE HENRY, '10. Asst. to Sec. National Housing Assoc. (1) 343 Undercliff Ave., Edgewater, N. J. (3) and (2) 105 E. 22d St., New York City.

CREMER, CECIL ANDREWS, M.E., '13. (1) 79 Ten Broeck St., Albany, N. Y. (2) and (3) Consolidated Car Heating Co., Albany, N. Y.

CREVELING, JOHN LEROY, '95. Address not known.

CRIPPIN, CHARLES HENRI, '15. Rampart, Alaska.

CRISPIN, CLARENCE GEARHART, M.E., '02. Evans Bldg., Berwick, Pa.

CROLL, ANDREW GILBERT, M.E., '95. Gen. Supt. Atlas Portland Cement Co. 30 Broad St., New York City. A. S. M. E.

CROLL, EDWARD HENRY, '09. 40 15th St., Buffalo, N. Y.

CRONAN, CLIFFORD BRODERICK, M.E., '15. (1) 13 Severance St., Shelburne Falls, Mass. (2) and (3) Care Remington Arms Co., Bridgeport, Conn.

CRONK, WILLIAM CALVIN, '12. South St., Montour Falls, N. Y.

CROSBY, EDWIN STANISLAU, M.E., '10. 1320 W. State St., Trenton, N. J.

CROSBY, MILTON ELWOOD, M.E., '16. 2536 5th Ave. S., Minneapolis, Minn.

CROSIER, GEORGE STANLEY, M.E., '06. 150 Lexington Ave., Buffalo, N.Y.

CROSS, CHARLES MORO, M.E., '04. Electrical Engr. (2) Ridgway Dynamo & Engine Co., Ridgeway, Pa. (3) 506 Kearsage Ave., Ridgeway, Pa.

CROSS, CHARLES NORMAN, M.E., '06. (2) and (3) Asst. Prof. Stanford Univ., Palo Alto, Cal. (1) 340 Embarcadero Rd., Palo Alto, Cal.

CROSS, CHARLES WOOD, M.E., '01. 820 Ford Bldg., Detroit, Mich.

CROSS, DAVID ANDERSON, '11. Address not known.

CROSS, FRANK LEONARD, M.E., '93. Mech. Engr., Cross Paper Feeder Co. 185 Summer St., Boston, Mass.

CROSS, HARRY VAN HEUSEN, '03. Fultonville, N. Y.

CROSS, ROYAL JOSEPH, M.E., '11. 19 Speedway Ave., Newark, N. J.

CROSSMAN, DONALD MCKAY, M.E., '10. (1) and (3) Huntington, L. I., N. Y. (2) Asst. Mgr., Publicity Dept., Niles-Bement-Pond Co., 111 Broadway, New York City.

CROSSMAN, FRED ANDREW, M.E., '90. (2) and (3) Lumber Merchant and Mfgr., Watson Bldg., Kingfield, Me. (1) Church St., Kingfield, Franklin Co., Me.

CROSSMAN, GILBERT, M.E., '98. Huntington, L. I., N. Y.

CROUCH, CALVIN HENRY, M.E., '92. (1) 513 S. 6th St., (2) and (3) Univ. of N. Dak., Grand Forks, N. Dak.

CROUSE, J. LANSING, M.E., '05. Pres. Mfg., Syracuse, N. Y. 523 Oak St., Syracuse, N. Y.

CROWELL, FREDERICK RICHMOND, JR., M.E., '12. 978 Lorimer St., Brooklyn, N. Y.

CRUMB, WILLIAM HANFORD, '95. Engr. and Contractor, 1423 Monadnock Bldg., Chicago, Ill. 1538 E. 66th St., Chicago, Ill.

CRUMP, STANLEY FELIX, '05. Pittsford, N. Y.

CRUZ, HENRIQUE BARBOZA DA, '92. Address not known.

CUDDEBACK, FRANK ELTING, M.E., '05. General Electric Co., Syracuse, N. Y.

CUERVO, MANUEL VICTORINO, M.E., '06. Ingenio Nueva Paz, Palos, Havana, Cuba.

CUERVO, RAUL SILVIO, M.E., '12. Ingenio Nueva Paz, Palos, Havana, Cuba.

CULBERTSON, WILLIAM RAY, M.E., '14. Engineering and Drafting. Ford Motor Co., Denver, Col. (1) 951 S. High St., Denver, Col. (2) and (3) Ford Motor Co., Denver, Colo.

CULLEN, CHARLES RAYMOND, '08. Address not known.

CULLUM, RUDOLPH LUTTGEN, M.E., '15. 239 West 107th St., New York City.

CUMMINGS, Owin P., M.E., '94. Supt. Construction, V. B. See Elect. Elev. Co. (2) and (3) 220 Broadway, New York City. (1) 48 W. 51 St., New York City. A. S. M. E.

CUMPSTON, Ed. H., jr., '09. Patent Att. (1) 1050 Univ. Ave., Rochester, N. Y. (3) 28 Strathallan Park, Rochester, N. Y.

CUNDALL, Harold Chester, M.E., '15. 212 Elm Ave., Webster Groves, Mo.

CUNNINGHAM, George Hamilton, M.E., '08. Asst. Supt. of Construction. (2) Anaconda Copper Mining Co., Anaconda, Mont. (3) Box 501, Anaconda, Mont. A. S. M. E., Am. Inst. Mining Engrs., Mont. Soc. of Engrs.

CUNNINGHAM, Roy Howard, M.E., '11. (1) 1520 Kanawah St., Charleston, W. Va. (2) and (3) 302 Natl. City Bank Bldg., Charleston, W. Va.

CUNNINGHAM, Secor, jr., M.E., '15. (2 and (3) Care Commonwealth Edison Co., Chicago, Ill. (1) 950 Lake Shore Drive, Chicago, Ill.

CUNNINGHAM, Thomas Percival, '09. (1) Sag Harbor, N. Y. (2) and (3) Supt. Engr., 1170 West Farms Rd., Bronx, New York City.

CURNOW, George Trevilyan, B.M.E., '84. Municipal Bldg., Brooklyn, N. Y. Home 342 4 St., Brooklyn, N. Y.

CURRAN, Sherwood S., M.E., '04. 90 Seneca St., Utica, N. Y. 1416 Oneida St., Utica, N. Y.

CURRIE, James Elmer, '08. Care Newark Electrical Co., The Arcade, Newark, Ohio.

CURRY, Henry Milo, jr., M.E., '09. 1273 Shady Ave., Pittsburg, Pa.

CURTIN, George Monroe, M.E., '13. Sec. and Director of Curtin, Herbert Mfg. Co. (2) and (3) Gloversville, N. Y. (1) 117 S. Main St., Gloversville, N. Y.

CURTIS, Allen, M.E., '00. (1) 924 West End Ave., New York City. (2) and (3) 30 Broad St., New York City.

CURTIS, Frank, '76. Minot, N. Dak.

CURTIS, Frederick Allan, '07. 245 S. 1st St., Mt. Vernon, N. Y.

CURTIS, Greeley S., M.E., '96. Aviation Eng. and Treas. The Burgess Co., Marblehead, Mass. Marblehead, Mass. A. S. M. E.

CURTIS, Harry Leroy, M.E., '06. 30 Broad St., New York, N. Y.

CURTIS, John Daniel, M.E., '96. Elec. Engr., J. Livingston Co., 70 East 45th St., New York City. Box 85, E. Pleasantville, N. Y.

CURTIS, Robert Crawford, '07. Cochranton, Pa.

CURTIS, Rossoe Earle, M.E., '14. Draftsman, Coatesville Boiler Wks. (2) and (3) Coatesville Boiler Works, Coatesville, Pa. (1) Y. M. C. A. Bldg., Coatesville, Pa.

CURTIS, Charles B., jr., M.E., '09. Sales and Engrg. (2) Wickes Boiler Co., Saginaw, Mich. (3) 924 Center Ave., Bay City, Mich. A. S. M. E.

CURTISS, Clarence James, M.E., '01. U. S. Coast Guard, Savannah, Ga.

CURTISS, Edward Whitehead, B.M.E., '80. Sheffield, Mass.

CURTISS, Edwin Stair, M.E., '06. (1) 2443 Prospect Ave., Cleveland, O. (2) and (3) Care Cleveland Trust Co., Cleveland, O.

CURTISS, George Warren, M.E., '12. (1) 116 Grove St., Tarrytown, N. Y. (2) and (3) 117 S. Main St., Gloversville, N. Y.

CURTISS, Henry P., M.E., '96. Sales Engineer. (3) and (1) 594 Centre St., Newton, Mass. (2) 120 Milk St., Boston, Mass.

CUSHING, Nicholas Cooke, M.M.E., '97. (1) and (3) 30 Church St., New York City. (2) Dept. Docks & Ferries, New York, N. Y.

CUSHING, Prentice, M.E., '06. (1) 27 Madison St., Brooklyn, N. Y.

CUSHING, William Whelan, '05. Civil Engr., 330 Greene St., Hamilton, Ont., Can.

CUSHMAN, H. B., M.E., '16. 55 Caryl St., Yonkers, N. Y.

CUTTER, Robert Delamere, M.E., '09. 1946 Iglehart Pl., St. Paul, Minn.

CUTTS, Frederic, M.E., '97. Office Manager G. E. Co. (1) 278 Canner St., New Haven, Conn. (2) and (3) Care General Electric Co., New Haven, Conn. Engineers Club, New York.

CUYLE, John Jay, M.E., '00. Hazleton House, Hazleton, Pa.

DABOLL, Henry Gaylord, M.E., '03. 110 Ruskin Ave., Syracuse, N. Y.

DAGGETT, Hiram Choate, '16. In charge of Contact Sulfuric Acid Plant and Nodulizing Iron Ore Plant. (1) and (3) 2732 Main St., Buffalo, N. Y. (2) General Chemical Co., Buffalo, N. Y.

DAGGETT, Royal Bradford, M.E., '94. 31 State St., Boston, Mass.

DALE, LeRoy Eldridge, Spec., '12. Care Mrs. E. S. Brown, 5 The Harston, Syracuse.

DALEY, Roland Bigelow, M.E., '14. Lumber Yard Auditor. (1) 4839 Dorchester Ave., Chicago, Ill. (2) 1224 N. 4th St., St. Joseph, Mo. (3) 101 S. 17th St., St. Joseph, Mo.

DALLER, Adrian Oskamp, '12. Care J. C. Daller, 417 Vine St., Cincinnati, Ohio.

DALBY, Archibald Baxter, '96. Red Bank, N. J.

DALRYMPLE, William Dunn, '13. Care John H. Dalrymple, Forest Park, Baltimore, Md.

DALTON, William, M.E., '90. Mechanical Engineer. (1) Benkendaal, Schenectady, N. Y. (2) and (3) Steel and Ordnance Co., Washington, D. C. A. S. M. E., Engineers Club of N. Y. City.

DALZELL, Charles Brown, M.E., '02. 81 N. William St., Little Falls, N.Y.

DALZELL, Chester Goodale, M.E., '00. Great Barrington, Mass.

DALZELL, William Cox, jr., M.E., '00. Valatie, N. Y.

DAMON, Frederick Henry, M.E., '08. 97 Jefferson Ave., Rochester, N. Y.

DAMON, Wm. Timothy, '11. 812 W. 3 Ave., Corsicana, Tex.

DAMSKY, Charles David, M.E., '17. 112 Washington St., Utica, N. Y.

DANA, Harold Edward, '08. 1057 Bergen St., Brooklyn, N. Y.

DANDRIDGE, Edmund Pendleton, M.E., '05. (2) and (3) Stephen-Adamson Mfg. Co., Oliver Bldg., Pittsburg, Pa. (1) 7038 Reynolds St., E. E., Pa.

DANFORTH, Francis Jenkins, M.E., '03. 10 Bridge St., New York, N. Y.

DANFORTH, Henry Albert, '98. Dealer in Bldg. Material. (1) (2) and (3) Charleston, Mo.

DANFORTH, Richard Eugene, M.E., '91. General Manager. (2) and (3) Pub. Serv. Ry. Co., Newark, N. J. (1) 7 Central Ave., Newark, N. J.

DANN, William James, '08. 927 State Life Bldg., Indianapolis, Ind.

DARBY, Clifford Torrey, M.E., '06. North Branch, N. J.

DARLING, Alan Graeme, M.E., '11. (2) and (3) Gen. Supt., Great Northern Power Co., Duluth, Minn. (1) 301 Wenilworth Ave., Duluth, Minn. A. I. E. E.

DARLING, George, '74. Peruville, N. Y.

DARLING, Nelson Jarvie, M.E., '07. Gen. Elec. Co., Erie, Pa.

DARLINGTON, Philip Jackson, M.E., '91. 235 Sisson Ave., Hartford, Conn. 67 Temple St., Hartford, Conn.

DARLOW, Alfred Miltenberger, M.E., '06. Asst. to Pres. and Supt. of Motive Power. (1) and (3) University Club, 546 Del. Ave., Buffalo, N. Y. (2) Buffalo & Susquehanna R. R. Corp., 980 Ellicott Square, Buffalo, N. Y. A. S. M. E.

DARNELL, Harry Arthur, '15. 1433 Union Ave., Memphis, Tenn.

DARRIN, David, M.E., '11. (1) 523 W. 121 St., New York City. (2) and (3) 404 Decatur St., Brooklyn, N. Y.

DAUCHY, Otis Burr, '93. Farmer. Townsend, Vt.

DAUMONT, Louis Burhaus, M.E., '09. 2540 Boulevard, Jersey City, N. J.

DAVIDSON, Benjamin Goodell, M.E., '16. 709 Prospect St., Sault Ste. Marie, Michigan.

DAVIDSON, Chas. Parker, jr., M.E., '13. 1525 Adams Ave., Scranton, Pa.

DAVIDSON, James Holroyd, '10. 610 Central Bldg., Los Angeles, Cal.

DAVIDSON, John, jr., M.E., '09. 525 Bryson St., Youngstown, O.

DAVIDSON, Morris Way, '14. 1221 South 3d St., Louisville, Ky.

DAVIDSON, Robert Irving, M.E., '99. Wiscoy, N. Y.

DAVIDSON, William Harold, M.E., '14. 1525 Adams Ave., Scranton, Pa.

DAVIES, Edw. Livingston, M.E., '07. 314 W. 77th St., New York City.

DAVIES, John P., M.E., '03. Office Engr., Structural and Mech. Civil Engineer. (2) and (3) 29 Broadway, New York City. (1) Edgar Lane, Hastings-on-Hudson, N. Y. A. S. C. E.

DAVIS, Adam Clarke, jr., M.E., '14. 211 W. Ash St., Goldsboro, N. C.

DAVIS, Alexander Philips, M.E., '14. Glens Falls, N. Y.

DAVIS, Allan Irvine, M.E., '15. Remington Arms Co. 1025 Noble Ave., Bridgeport, Conn.

DAVIS, Calvin Edward, M.E., '12. Cazenovia, N. Y.

DAVIS, Cortland Woodbury, M.E., '07. Chemist and Supt. of Mfg. (2) and (3) Mantel Lamp Co., Chicago, Ill. (1) 5356 W. Madison St., Chicago, Ill.

DAVIS, Edward Stanton, '98. Chief Engr., Am. Shop Equipment Co., 1414 McCormick Bldg., Chicago, Ill.

DAVIS, Francis Daniel, M.E., '90. Engineer. Ore and Coal Handling Mchry. Wellman, Seaver, Morgan Co. (1) and (3) 2935 Somerton Rd., Cleveland Hgts., Ohio. (2) Central Ave. and E. 70th St., Cleveland, O. Cleveland Engineering Society.

DAVIS, Franklin, '11. 311 E. 22 St., Baltimore, Md.

DAVIS, George Henry, M.E., '92. Ford Bacon & Davis, Maison Blanche Bldg., New Orleans, La.

DAVIS, Henry Emerson, '07. Insurance Cotton Planting, 131 Lowell St., Peabody, Mass.

DAVIS, Henry Emerson, M.E., '09. 23 Sunset Pl., Utica, N. Y.

DAVIS, John Ransford, M.E., '15. Asst. foreman. (2) and (3) U. S. Gypsum Co., Oakfield, N. Y. (1) 47 S. Main St., Norwich, N. Y.

DAVIS, John Williams, M.E., '10. Instructor in E.E. (1) (2) and (3) Univ. of Ill., Urbana, Ill. Tau Beta Pi, A. I. E. E., Am. Phy. Soc.

DAVIS, John Yawger, '72. Dairy Farmer, Cayuga, N. Y.

DAVIS, Lee, M.E., '93. Planter. (1) (2) (3) Brunswick, Miss.

DAVIS, Max Warburton, M.E., '08. Asst. Examiner, Patent Office. 2518 17 St., Washington, D. C.

DAVIS, Oliver Henry, M.E., '04. Ithaca, N. Y.

DAVIS, Ralph, M.E., '11. Asst. Steam Engr., Jones & Laughlin Steel Co. (2) 323 Jefferson Ave., Scranton, Pa. (3) and (1) Franklin Hotel, Woodlawn, Pa.

DAVIS, Ralph Currier, M.E., '16. 42 Washington St., Mohawk, N. Y.

DAVIS, Robert Wood, M.E., '13. Care A. W. Wood, 1st Natl. Bank, Trenton, N. J.

DAVIS, Sydney Philip, M.E., '12. Foreman in Rifling Dept. (2) and (3) Remington Arms & Ammunition Co., 1025 Noble Ave., Bridgeport, Conn. (1) 33 Arch St., Milton, Pa.

DAVIS, William Gurley, M.E., '17. Mexico, N. Y.

DAVISON, Herbert W., '03. Sec., Rochester Motors Co., Inc. (2) and (3) 609 Driving Park Ave., Rochester, N. Y. (1) 75 Oriole St., Rochester, N. Y.

DAVISON, Thomas Edwin, M.E., '13. Electrical Engineer. (1) 718 Avenue A, Schenectady, N. Y. (2) and (3) Weeksbury, Floyd County, Ky. Associate Member A. I. E. E.

DAWKINS, DeWitt Clinton, '15. Sales Engr., Westinghouse Elect. & Mfg. Co., Wilkinsburg, Pa.

DAWLEY, Clarence A., M.E., '04. Consulting Engr. (2) and (3) 90 West St., New York. (1) 904 Watching Ave., Plainfield, N. J. A. S. M. E.

DAWSON, Charles Summner, M. E., '09. Power Engr., Scranton Elec. Co. (2) Care Scranton Elec. Co., Scranton, Pa. (1) and (3) Wenonah, N. J. Engineers Soc. of N. E. Pa., A. I. E. E., N. E. H. A.

DAWSON, Edwin Scott, M.E., '14. Roberts & Schaefer, Engrs. and Contrs. (2) Roberts & Schaefer, McCormick Bldg., Chicago, Ill. (1) and (3) 1225 Judson Ave., Evanston, Ill.

DAWSON, Horace L., M.E., '07. District Sales Mgr., Cutler Hammer Mfg. Co. (2) and (3) 1339 Peoples Gas Bldg., Chicago, Ill. (1) 1219 Maple Ave., Evanston, Ill. A. I. E. E.

DAY, Alfred Champney, M.E., '14. Salesman. (2) 112 W. Adams St., Chicago, Ill. (1) and (3) 550 Surf St., Chicago, Ill.

DAY, Charles H., M.M.E., '05. Enging. Dept., Grosselli Chemical Co. (2) and (3) Cleveland, O. (1) 81 Rosemont Road, Cleveland, O. A. S. M. E.

DAY, Charles Ivan, M.E., '05. Care H. E. Bemis, Fla. E. Coast, Hotel Co. St. Augustine, Fla.

DAY, George Edward, M.E., '09. 94 Ave. C., Bayonne, N. J.

DAY, George Wilcox, M.E., '01. Box 1219, Lockport, N. Y.

DAY, Irwin Williams, M.E., '06. Pres. United Light and Water Co., Connecticut. 100 Broadway, New York, N. Y. Soc. Naval Arch. and Marine Engrs., A. S. M. E.

DAY, Philip Lewis, M.E., '11. Central Tech. College, Brisbane, Australia.

DAY, Ralph Burnette, M.E., '06. Instructor, Cornell Univ., Ithaca, N. Y. Overlook Terrace, S. Aurora St., Ithaca, N. Y.

DAY, Rodney D., M.E., '06. Sales Mgr., William Tod Co., Youngstown, O. A. I. & S. I., Eng. Soc. of West. Pa.

DAY, Winterton James, M.E., '97. Salesman, Sales Dept., General Elec. Co. (2) Schenectady, N. Y. (1) and (3) Box 166, R. F. D. 7, Schenectady, N. Y. A. I. E. E.

DAY, William Asher, M.E., '86. 112 West Adams St., Chicago, Ill.

DAYTON, Paul Kuykendall, '05. 111 Broadway, New York, N. Y.

DEAN, Joel, '07. Rome, Ga.

DEAN, William Fairchild, '89. 56 Triller Ave., Toronto, Can.

DEAN, William Robert, '04. 925 High St., Bath, Me.

DE ANGELES, Marshall, M.E., '13. Traveling representative American Steel Foundries, Chicago, Ill.

DEANS, William, jr., M.E., '13. Instructor, Cornell University, Ithaca, N. Y. 903 N. Cayuga St., Ithaca, N. Y. A. I. E. E., Eta Kappa Nu.

DEARBORN, Richard Harold, M.E., '00. Corvallis, Ore.

DEAN, Clarence W., M.E., '09. 710 Jefferson St., Buffalo, N. Y.

DeBARD, Davis M., M.E., '09. Mgr. Power Sales Dept. (2) and (3) Care Edison Elec. Ill. Co., 42 Main St., Brockton, Mass. (1) 21 Ash St., Brockton, Mass. N. E. L. A.

DeBOLT, George Washington, jr., '14. Fairmount, W. Va.

DECKER, Glennard C., M.E., '09. Ship Draughtsman, Hull Est. Dept. (1) and (3) P. O. Box 191, Newport News, Va. (2) Newport News Ship Bldg. & D. D. Co.

DECKER, Lyall, M.E., '08. Instructor, Eng. Dept., Univ. of Minn. (2) and (3) 111 Main Eng. Bldg., Univ. of Minn. (1) 611 Delaware St., Minneapolis, Minn.

DEDICKE, Carl Edward, M.E., '12. Asst. Supt., Felters Co. of Middleville, Middleville, N. Y. (1) (2) and (3) Middleville N. Y. Elks.

DEDLOW, C., '16. Address not known.

DEEMER, Arthur Passavant, M.E., '05. 213 Mifflin Ave., Wilkinsburg, Pa.

DEFFENBAUGH, Homer Crow, M.E., '06. Engineer and Asst. to Sec. (1) and (3) 3 Liberty Rd., Englewood, N. J. (2) 29 West 39th St., New York City. A. I. E. E.

DeGROAT, Wilson Fields, M.E., '17. Nichols, N. Y.

DeLANEY, Wesley La Mont, M.E., '07. 430 Washington Ave., Philadelphia, Pa.

DeLAINATER, VAN NESS, M.E., '00. Asst. Sales Mgr., Motor Bearings Division. (1) and (3) 3066 Gr. Boulevard, W. Detroit, Mich. (2) Hyatt Roller Bearing Co., Detroit, Mich. A. S. M. E.

DELANO, ARTHUR MORTON, '03. 301 Orange Rd., Montclair, N. J.

DELANO, CURTIS, M.E., '12. Mech. Eng. (1) and (3) 105 Howard St., Newtonville, Mass. (2) Submarine Signal Co., Boston, Mass.

DELANO, MILTON, M.E., '95. Retired. Canastota, N. Y.

DELANO, WARREN VARNEY, M.E., '98. 27 Haigh Ave., Schenectady, N. Y.

DELANY, CHARLES HENRY, M.M.E., '02. Engr. in Steam Dept., Pacific Gas and Elec. Co., 445 Sutters St., San Francisco, Cal. A. S. M. E., Nat. Elec. Light Ass.

De LORENZI, OTTO, M.E., '16. Engineer in Dept. of Tests and Research. (1) 3009 Live Oak St., Dallas, Tex. (2) Care Combustion Engineering Corp'n, 11 Broadway, New York City. (3) 355 West 123d St., New York City. A. S. M. E.

De LARME, ALFRED CHINA, '15. (1) 108 N. Washington St., Sumter, S. C. (3) Box 278, Sumter, S. C.

DEMING, ROBERT, M.E., '00. 1302 National Bank Bldg., Cleveland, O.

DENMAN, JOHN, JR., '95. Address not known.

DENNIS, SAMUEL JAMES, M.E., '06. Bureau of Plant Industry. 126 R. St. N. E., Washington, D. C.

DENNISON, BOYD COE, M.M.E., '08. 607 Worth St., Pittsburg, Pa.

DENNISON, FRANK GRAY, M.E., '15. 210 Woodlawn Terrace, Waterbury, Conn.

DENNY, ANDREW CHAMBERS, M.E., '15. Care Seattle Construction & Drydock Co., Seattle, Wash.

DENNY, JAMES McCORMICK, '92. 1501 Master St., Philadelphia, Pa.

DENNY, ROBERT CAMPBELL, M.E., '03. Farrandale Ave., Halcyon Pk., Bloomfield, N. J.

DENTON, ALPHEUS PENN, M.E., '04. Pres. and Mgr., Denton Eng. & Cons. Co., Kansas City, Mo.

DENTON, FRANCIS DOUGLAS, '07. Estimator, St. Louis Street Dept., 325 City Hall, St. Louis. Res. 5400 Vernon Ave., St. Louis, Mo.

DEPEW, RICHARD HENRY, '13. Rancher. Dayton, Wyo.

DERHAM, JOSEPH JOHN, M.E., '17. Rosemont, Pa.

DE ROODE, LOUIS REMSEN, '13. Address not known.

DERR, RALPH, '00. 83 N. River St., Wilkes-Barre, Pa.

DERR, OLIN FELL, M.E., '04. 66 Harrison St., E. Orange, N. J.

DESBECKER, HAROLD CLARENCE, M.E., '08. Adv. Mgr. and Supt. (2) and (3) Isaac Hamburger & Sons, Baltimore. (1) 821 Newington Ave., Baltimore, Md.

DESBECKER, JOHN WARNER, M.E., '06. 302 West 22 St., New York City.

De REVERE, ARTHUR W., M.E., '11. Mec. and Sales Engineer. (1) 155 E. 22d St., Brooklyn, N. Y. (2) and (3) Green Fuel Economizer Co., Room 808, 90 West St., New York. A. S. M. E.

DeVED, CHARLES McCLELION, M.E., '06. Sales Engineer. (1) and (3) 446 S. 55th St., Philadelphia, Pa. (2) Commonwealth Trust Bldg., Philadelphia, Pa.

DeVED, HORRACE WARREN, M.E., '03. 103 Whitestone Ave., Flushing, L. I., N. Y.

DEVENDORF, WILLIAM FREDERICK, M.E., '98. Prof. W. F. Devendorf & Co. 26 Vassar St., Rochester, N. Y. 470 Court St., Rochester, N. Y. A. S. H. & V. E.

DEW, DONALD HICKS, M.E., '15. 4 Onondago Place, Syracuse, N. Y.

De WEIN, GEORGE FREDERICK, M.E., '97. 2442 Prairie St., Milwaukee, Wis.

DEWEY, DONALD MACK, M.E., '14. (1) 4361 Greenwood Ave., Chicago, Ill. (2) and (3) 40 Bellevue Place, Chicago, Ill.

DEWEY, GEORGE STEELE, M.E., '05. 101 James St., Goldsboro, N. C.

DEWEY, THOMAS AUGUSTUS, M.E., '06. Machinery and Supply Business. Goldsboro, N. C.

DeWITT, BRINTON BROWN, '10. Apo. Central San Cristobal, Naquabo, P. R.

DeWITT, HARRY ALONZO, M.E., '09. 41 N. Wendall Ave., Schenectady, N. Y.

DEYO, AUSTIN WELD, M.E., '13. Larrabee-Deyo Motor Truck Co., Binghamton, N. Y.

DEWSNAP, SAMUEL BROWN, '92. 123 E. 34 St., New York, N. Y.

DEWSNAP, STANLEY, M.E., '15. 20 Wilcox Ave., Middletown, N. Y.

DEXTER, BAYARD PUTNAM, '10. Mechanical Engineer, Leavitt Machine Co. Orange, Mass.

DEXTER, FRANK H., M.E., '98. Engr. 391 8th St., Brooklyn, N. Y.

DEXTER, ROBERT LEE, M.E., '10. Sec. Bates Bros. Co., Athol, Mass. 239 S. Main St., Athol, Mass.

DIAZ, CARLOS LECUNA, '97. Caracas Venz.

DIBRELL, LOUIS NELSON, '07. Electrical Engr. 990 Main St., Danville, Va.

DICK, WILLIAM AMZI, M.E., '92. Electrical Engineer. (1) and (3) 910 Chislett St., Pittsburg, Pa. (2) Westinghouse Elec. & Mfg. Co., Pittsburg, Pa. Fellow A. I. E. E., S. A. E.

DICKERMAN, JOHN ALONZO, JR., M.E., '06. (1) 111 Peabody St., Gardner, Mass. (2) and (3) Chair Mfg., Gardner, Mass.

DICKERSON, WILBER HOWARD, M.E., '99. Care Albert Dickerson, Union, N. Y.

DICKERT, D. S., M.E., '11. Mech. Engrg. (2) 1814 Carey Ave., Cheyenne, Wyo. (1) 8 Rookery Apts., Cheyenne, Wyo. (3) P. O. Box 784, Cheyenne, Wyo.

DICKINSON, DAVID KNOX, Sp.M., '91. 511 Washington Ave., Wilmette, Ill.

DICKINSON, WILLIAM ELMORE, M.E., '04. Professor W. Va. College, Morgantown, W. Va.

DIEDERICHS, HERMAN, M.E., '97. Professor, Cornell University. Sibley College, Ithaca, N. Y.

DIEDERICHS, HUGO N., '17. Dolgeville, N. Y.

DIEDERICHS, WILLIAM JACOB, M.E., '12. Instructor, Cornell University. Ithaca, N. Y.

DIEHL, CLIFFORD SAMUEL, M.E., '07. Pres. Diehl Fireworks Co., Lawrenceburg, Ind.

DIEMER, HARRY MARSHALL, M.E., '03. Electric Controller & Mfg. Co. 1893 E. 90 St., Cleveland, O.

DILTS, FRANK BUTLER, '94. Pres. Dilts Machine Works, Fulton, N. Y. 140 S. 1st St., Fulton, N. Y.

DIMENT, ELLWOOD, M.E., '09. Mgr. Minetto Meriden Co. Minetto, Meriden Co., Minetto, N. Y.

DINGENS, CARL LOUIS, M.E., '96. 229 Chestnut St., Holyoke, Mass.

DINGLE, HOWARD, M.E., '05. 1860 E. 81 St., Cleveland, O.

DISNEY, IRVIN P., M.E., '88. Examiner, U. S. Pat. Office. 1212 B. St., S. E., Washington, D. C.

DITTMAR, RICHARD ALEXANDER, M.E., '13. Supt. of Power. (1) 422 N. 7th St., Hannibal, Mo. (2) Atlas Portland Cement Co., Hannibal, Mo. A. I. E. E.

DIVINE, JOHN HOWARD, M.E., '05. Care Dwight Divine & Sons, Ellenville, N. Y.

DIX, CHARLES BILLINGS, M.E., '88. Engr. Glens Falls, N. Y.

DIX, EDGAR HUTTON, JR., M.E., '14, M.M.E., '16. (2) Instructor Mech. Lab., Cornell University. (3) and (1) 206 W. Green St., Ithaca, N. Y. Sigma Xi.

DIX, FRANK STILLMAN, M.E., '03. 163 Prospect Pl., Brooklyn, N. Y.

DIX, HOWARD W., M.E., '11. Patent Atty. McLachlen Bldg., Washington, D. C.

DIX, JOHN WOODRUFF, M.E., '94. Carnegie Steel Co., Pittsburg, Pa.

DIXON, RICHARD MATHER, M.E., '13. 518 Van Buren St., Milwaukee, Wis

DIXON, WALLACE CLARK, M.E., '13. 113 Elm St., Ilion, N. Y.

DOBSON, GEORGE, M.E., '09. Tel. Engr., Western Elec. Co. (2) and (3) 463 West St., New York City. (1) R. F. D. 1, Passaic, N. J. A. I. E. E.

DODGE, CLARENCE BUTTON, '04. 1018 S. Main St., Los Angeles, Cal.

DODGE, FRANCIS MILLS, M.E., '13. Manufacturer of Scales. (1) 269 McLean Ave., Yonkers, N. Y. (2) and (3) The Dodge Scale Co., 126 Eleventh Ave., New York City.

DODGE, JOHN HENRY, '10. 2100 Scott St., Little Rock, Ark.

DODGE, JOHN ORRIS, M.E., '04. 710 W. 3 St., Dixon, Ill.

DODGE, STANWOOD, M.E., '13. Standard Oil Co., Fullerton, Cal. R. F. D. 3, Box 71.

DODS, JOHN PALLISER, M.E., '08. Auto Blue Book Co. 910 S. Michigan Ave., Chicago, Ill.

VAN DER DOES DE BYE, ARNOUD JACOB JONS, M.E., '08. Cornell Univ., Ithaca, N. Y.

DOEPP, LOUIS ERNEST, '94. Address not known.

DOHENY, CLARENCE WILLIAM, '13. Box 499, Cobourg, Ont., Canada.

DOIG, JOHN ROBERT, M.E., '08. 914 Cranberry St., Erie, Pa.

DOLAN, THOMAS RUSSELL, '12. 105 Fifth Ave., New York City.

DOLL, WILLIAM ELDER, M.E., '11. Salesman, Henry R. Worthington. (1) and (3) 3962 Morgan St., St. Louis, Mo. (2) 701 Leclede Gas Bldg., St. Louis, Mo. St. Louis Society of Engineers.

DONALDSON, RODERICK DOUGLAS, M.E., '07. Industrial Power Engineer. (2) Care United Gas and Power Co., 1401 Arck Sts., Philadelphia, Pa. (3) and (1) 101 Llanfair Rd., Ardmore, Pa. Natl. Electric Light Assn.

DONOVAN, BERNARD FAY, '97. Wholesale Grocer. Clifton Forge, Va.

DONOVAN, RICHARD JAMES, M.E., '00, M.M.E., '01. 1456 Frick Annex, Pittsburg, Pa.

DOOLITTLE, ALBERT HALL, '04. Sales and Adv. Mgr. (1) 1181 Second Ave., Detroit, Mich. (2) and (3) Zenith Carburetor Co., Detroit, Mich.

DOOLITTLE, FRANK EDWARD, JR., '11. 132 W. Water St., Elmira, N. Y.

DOOLITTLE, HAROLD LUKENS, M.E., '06. 127 N. Catalina Ave., Pasadena, Cal.

DOOLITTLE, LEWIS JOSEPH, M.E., '93. 2 Rector St., New York, N. Y.

DORNER, WILLIAM FREDERICK, M.E., '01. Supt. Gas Works. Gas Wks., Rich. and Tioga Sts., Philadelphia, Pa.

DORON, WILLIAM HYDE, M.E., '08. (1) 355 St. John Pl., Brooklyn, N. Y. (2) and (3) N. Y. Central R. R., New York City.

DORRANCE, GEORGE WRIGHT. 1346 Proctor St., Port Arthur, Texas.

DORRANCE, JOHN KNAPP, M.E., '10. Dorrance & Co., Houston, Texas.

DOUGHTY, HERMAN WILLIAM, M.E., '96. 379 Belmont Ave., Newark, N. J.

DOUGHTY, JOHN HENRY, M.E., '99. Mech. Eng. (2) L. & W. B. Coal Co., S. River St., Wilkes-Barre, Pa. (1) and (3) 1720 Wyoming Ave., Forty Fort, Pa. A. S. M. E., Engr. Club of Penn.

DOUGLAS, GEORGE ROSS, M.E., '14. 188 Linden St., Yonkers, N. Y.

DOUGLASS, HERBERT McNAIR, M.E., '07. Asst. Prof. Industrial Education. (2) State College for Teachers, Albany, N. Y. (1) and (3) 457 Morris St., Albany, N. Y.

DOUGLASS, LELAND SIDNEY, M.E., '10. 1899 E. 75th St., Cleveland, O.

DOWNE, HAMILTON BORDEN, M.E., '15. (2) and (3) American Radiator Co., Buffalo, N. Y. (1) 112 Anderson Pl., Buffalo, N. Y.

DOWNES, HENRY HACKETT, M.E., '08. 1426 Olive St., St. Louis, Mo.

DOWNEY, ARCHIBALD ST. JOHN, M.E., '99. 311 Hodge Bldg., Seattle, Wash.

DOWNING, FREDERICK BAGG, M.E., '95. Gen. Ins., 9 and Peach Sts., Erie, Pa.

DOWNS, FREDERICK, M.E., '14. 19 S. West St., York, Pa.

DOWNS, IRVING GARFIELD, M.E., '01. Asst. Engr. (2) L. B. Stillwell, 100 Broadway, New York City. (1) and (3) Hollis Ave., Hollis, N. Y. N. Y. R. R. Club.

DOWNS, LEON HAMILTON, '09. 22 Orange Ave., Goshen, N. Y.

DOYLE, ALFRED JOSEPH, M.E., '12. Junior Electrical Engineer. (1) Room 2431, 120 Broadway, New York City. (2) and (3) 242 Monroe St., Brooklyn, N. Y.

DOYLE, EDMUND MILLER, M.M.E., '96. Menlo Park, Cal.

DRAKE, ERNEST ALLEN, M.E., '99. Care Benjamin Electric Co., 120 S. Sagmon St., Chicago, Ill.

DRAKE, HAROLD ELLIS, M.E., '11. 499 N. Main St., Gardner, Mass.

DRAKE, JOHN THOMAS, '99. Asst. Engineer, D. L. & W. R. R. 137 E. Washington Ave., Washington, N. J.

DRAKE, MARCUS MOTIER, JR., M.E., '00. Mech. and Marine Engr. 17 Battery Place, New York City.

DRAKE, RAYMOND RODGERS, M.E., '05. (1) 535 Potomac Ave., Buffalo, N. Y. (2) and (3) 1210 Chamber of Commerce, Buffalo, N. Y.

DRAKE, WILLIAM ALLEN, '06. Portland, Ind.

DRESSER, SIDNEY RANDOLPH, M.E., '12. (1) 294 Green Ave., Brooklyn, N. Y. (2) and (3) 130 E. 15 St., care U. S. Elec. Lt. and Power Co., Brooklyn, N. Y.

DREYER, LEWIS, M.E., '11. 2880 Main St., Buffalo, N. Y.

DRISCOLL, WILLIAM MAURICE, '88. Driscoll Bros., Builders and Contractors. (2) and (3) S. Aurora St., Ithaca, N. Y. (1) 423 E. Seneca St., Ithaca, N. Y.

DRUAR, JOHN FENIMORE, '01. 312–316 Commercial Bldg., St. Paul, Minn.

DRULINER, FRANK L., '95. South Bend, Indiana.

DRUMM, JAMES COCHRAN, M.E., '11. 5601 Atherton Ave., Pittsburg, Pa.

DRURY, ALEXANDER GRETCHELL, M.E., '07. 836 Lincoln Ave., Cincinnati, O.

DUBOIS, CHESTER BUCK, M.E., '02. Designer. (1) and (3) 29 Park Pl., New Rochelle, N. Y. (2) Jones Speedometer, New Rochelle, N. Y.

DUBOIS, HENRY PASTOR, M.E., '07. 37 Wall St., New York, N. Y.

DUCKWORTH, WILLARD DEMAREST, '05. Address not known.

DUCLOS, AENEAS, M.E., '10. Chief Inspector, Wire & Cable Mfg. (1) and (3) 10 St. Matthew St., Montreal, Quebec, Can. (2) Northern Electric Co., Ltd., Montreal, Can.

DUDLEY, CARROLL SCRIBNER, M.E., '13. Plant Dept., N. Y. Tel. Co. (2) and (3) 205 E. Gray St., Elmira, N. Y. (1) 108 E. Hudson St., Elmira, N. Y.

DUFFY, EDWARD ALLEN, M.E., '03, M.M.E., '04. 604 North. Bank & Trust Bldg., Seattle, Wash.

DUKES, RICHARD GUSTAVUS, M.E., '96. Purdue Univ., Lafayette, Ind.

DULIN, HORACE, '05. Dulin & Martin Co., 1215 F. St., N. W., Washington, D. C.

DUMAS, CLAUDIO, JR., '06. Gelabert St., Matanzas, Cuba.

DUNBAR, DOUGLAS LINDSEY, '13. Dobbs Ferry, N. Y.

DUNBAR, LEO AUGUSTINE, M.E., '14. 38 Sherwood Ave., Rochester, N.Y.

DUNBAR, ROBERT HOWARD, '13. 169 Prairie Ave., Providence, R. I.

DUNCAN, HARRY LEE, M.E., '96. Patent Lawyer. 56 Liberty St., New York City.

DUNCAN, PETER SHONBERGER, JR., '98. Silica Rock Business. Hollidaysburg, Pa.

DUNHAM, WALTER EDWARD, M.E., '95. Supervisor Motive Power & Machy. (2) Chicago & Northwestern Ry., Winona, Minn. (1) 363 W. Wabasha St., Winona, Minn. A. S. M. E., A. S. T. U., A. R. M. M. A., M. C. B. A., Western R. G. Club. Inter. Ry. Fuel Assn.

DUNLAP, V. C., M.E., '16. Bowdoinham, Me.

DUNN, AMERY BOYD, '13. Sales Engineer. (2) Crocher Wheel Co., Ampere, N. J. (1) and (3) 96 N. 18th St., East Orange, N. J.
DUNN, CHARLES W., M.E., '93. Robert W. Hunt & Co., Engrs. 38 Linnean St., Cambridge, Mass. A. S. M. E.
DUNN, JOSEPH HARRISON, '05. Salesman, care J. & J. Drysdale Co., 410 Calle Peru, Buenos Ayres, A. R.
DUNN, THOMAS CHACE, '90. Address not known.
DUNN, THOMAS LYTLELAND, M.E., '06. Savannah Electric Co., Savannah, Ga.
DU PRIEST, JOHN RANDOLPH, M.E., '13. (1) 1619 Jefferson St., Madison, Wis. (2) and (3) Care University of Wisconsin, Madison, Wis.
DURANT, WILLIAM CLARKE, '04. Electrical Engineer. Chi Psi Lodge, Schenectady, N. Y.
DURHAM, GLEN GIFFEN, M.E., '05. Elec. Engr. 616 Heed Bldg., Philadelphia, Pa. Asst. A. I. E. E., Mem. S. P. E. E., Jovian.
DURYEA, HOWARD, M.E., '07. Asst. Eng. Dept. N. E. L. & P. Co., New York City. (2) and (3) 448 E. 26th St., Brooklyn. (1) 130 E. 15th St., New York City. A. I. E. E., N. E. L. A.
DUSINBERRE, GEORGE BROWN, M.E., '86. 423 High Ave., S. E., Cleveland, O.
DUTCHER, F. H., M.E., '17. 69 Plymouth St., Montclair, N. J.
DWIGHT, FRANCES BARTOW, M.E., '09. Boslowick, Falmouth, Cornwall, England.
DUTNEY, GEORGE VALENTINE, M.E., '10. 4017 Cambridge St., Pittsburg, Pa.
DU VALL, BRUCE ROBERTSON, '12. Minot, N. D.
DYE, CHARLES FREDERICK, M.E., '14. Insurance Business., care H. W. Brown & Co., 435 Walnut St., Philadelphia, Pa.
DYER, C. H., M.E., '16. Maryland Steel Co., Sparrow's Pt., Md.
DYER, WALTER CHENEY, M.E., '07. (1) 5009 Washington Ave., Chicago, Ill. (2) and (3) Care Buda Co., Hanny, Ill.
DYETT, HERBERT THOMAS, M.E., '97. (1) 313 N. George St., Rome, N. Y. (2) and (3) Care The Wire & Telephone Co. of America, Rome, N. Y.
DYETT, JAMES HATHEWAY, M.E., '92. (1) 5 Penhurst Park. (2) and (3) The Hard Mfg. Co., Buffalo, N. Y.
EAGAN, GEORGE ARTHUR, M.E., '06. (1) Princeton Ave., Swarthmore, Pa. (2) and (3) 805 Stephen Girard Bldg., Philadelphia, Pa.
EAGAN, WALTER HAROLD, '14. 1934 Biltmore St., Washington, D. C.
EAGER, EDWARD HOSMER, '13. Salesman, B. F. Goodrich Co. (2) and (3) 401 Mission St., San Francisco, Cal. (1) 2333 Charming Way, Berkeley, Cal.
EARLE, HENRY CURTIS, M.E., '93. 43 W. Upsal St., Mt. Airy, Phila., Pa.
EARLE, SAMUEL BROADUS, M.E., '02. Engr. Dept., Prof. Mech. Engr., Clemson College. Box 53, Clemson College, S. C. A. S. M. E.
EARLE, THEODORE, M.E., '06. 165 Broadway, New York City.
EARNSHAW, RALPH, M.E., '17. P. O. Box 282, Manila, P. I.
EASTLAND, SEABOM, JR., '10. 1514 23 Ave., Meridian, Miss.
EASTMAN, FRANK HALL, M.E., '99. Sales Engineer. 1330 New York Ave., Washington, D. C.
EASTMAN, ROBERT LOVEJOY, M.E., '14. 2162 E. 55th St., Cleveland, O.
EASTMAN, WALTER LANE, M.E., '93. 6001 Etyel Ave., St. Louis, Mo.
EASTON, THOMAS K., '16. Eng. and Sales Dept. (1) 1512 Dearborn Ave., Chicago, Ill. (2) and (3) Chalmers & Williams, Chicago Heights, Ill.
EASTWOOD, SIDNEY KINGMAN, M.E., '13. Lay & Eastwood, Engrs. and Conts., Owego, N. Y.
EATON, HOWARD FURMAN, M.E., '12. Northeast, Pa.
EATON, JOHN MORTON, M.E., '10. 1070 3 St., Beaver, Pa.
EATON, LEON SCHULTZ, M.E., '11. 22A 19 Ave., Lachine, Que., Can.
EATON, PAUL BURNS, M.E., '11. Tamphan Eng. College, Tamphan, China.
EBAUGH, LIONEL ALBERT, M.E., '17. 525 Orchard Ave., Bellevue, Pa. Eta Kappa Nu.
EBBERTS, ANDREW HOWARD, '09. Salesman. (1) and (3) 1206 Heberton Ave., Pittsburg, Pa. (2) Phoenix Glass Co., Pittsburg, Pa.
EBELING, FREDERIC OLIVER, M.E., '09. Sales Engr. Rossman Ave., Hudson, N. Y. A. S. M. E.
EBERHARDT, HENRY EZRA, M.E., '06. Sec. Cornell Club of North N. J. 49 Baldwin Ave., Newark, N. J.
EBERSOLE, WILLIAM GLENN, '13. (1) 2135 St. James Ave., Cincinnati, O. (2) and (3) Proctor & Gamble Dist. Co., Cincinnati, O.
EBERT, LAURENCE RUDOLPH, M.E., '05. U. S. Gen'l Land Office, Coal Fields, Alaska. 313 Main St., Vancouver, Can.
ECCLESTON, ROBERT COOK, M.E., '00. Assistant Engineer. 416 Allenhurst Ave., Ridgway, Pa.
ECKART, WILLIAM RANKINE, M.E., '05. Professor Leland Stanford Univ. Leland Stanford Univ., Palo Alto, Cal.
ECKERT, HARRY ANDREW, M.E., '02. 313 S. Granada St., Alhambra, Cal.
ECKERT, SAMUEL BLATZ, M.E., '08. 2024 De Lancey St., Philadelphia, Pa.
ECKLEY, WINFIELD, M.E., '17, B.S. R. F. D. 1, LaGrande, Ore.
EDDY, LAWRENCE, M.E., '14. 33 Pinckney St., Boston, Mass.
EDDY, LOYD CHAMPLIN, M.E., '10. Shawinigars Technical Institute, Shawinigar Falls, Quebec, Canada.
EDDY, WILTON N., M.E., '16. Testing Dept., Gen. Elec. Co., Schenectady, N. Y. 203 Seward Pl., Schenectady, N. Y. A. I. E. E.
EDGAR, G. B., '16. 174 Perry Ave., W. New Brighton, N. Y.
EDGERTON, CHAUNCEY TOWNSEND, '01. Salesman. (1) 4232 Fifth Ave., Pittsburg, Pa. (2) and (3) Care Crucible Steel Co. of America, Pittsburg, Pa.
EDGERTON, MORGAN BROWN, '94. Mechanical Engr. (2) and (3) Harvester Bldg., Chicago, Ill. (1) 3100 Home Ave., Berwyn, Ill.
EDGETT, GEORGE ERNEST, M.E., '04. Supt. of Gasoline Dept. (2) The Carter Oil Co., 208 Central Natl. Bank Bldg., Tulsa, Okla. (1) and (3) 719 S. Olympia Ave., Tulsa, Okla.
EDLUND, SIDNEY WENDELL, '12. 250 Madison St., Brooklyn, N. Y.
EDMONDS, GEORGE STRETTLE, M.E., '95. Supt. of Shops, Delaware & Hudson Co. Del. & Hudson Co., Watervliet, N. Y.
EDMONDS, SAMUEL PRESTON, M.E., '93. Lieut. U. S. Coast Guard, Ret'd. Mgr. Universal Life Savings Eq. Dept. Robinson-Rhodes Co., Newark N. J. Treasury Dept., Washington, D. C.
EDMONSTON, CLARENCE LOWRIE, M.E., '02. R. D. 1, Box 11, Rivera, Cal.
EDMONDSON, WILLIAM GEORGE, M.E., '92. Mec. Eng., Interstate Commerce Comm. (1) 431 Mt. Washington Drive, Los Angeles, Cal. (2) and (3) 731 Wells Fargo Bldg., San Francisco. Am. Ry. Master Mechanics Association. New York Railroad Club.
EDMUNDS, LOUIS LAKE, M.E., '05. Chief Engineer. (1) Crockett, Cal. (2) and (3) Cal. and Hawaiian Sugar Refining Co., Crockett, Cal. A.S.M.E.
EDSALL, HENRY JACKSON, M.E., '96. Salesman. (2) and (3) Link Belt Co., Nicetown, Philadelphia, Pa. (1) Willow Grove, Pa. Engineers Club of Phila.
EDWARDS, CHARLES EUGENE, '13. 1719 First St., N. W., Washington, D. C.
EDWARDS, HAROLD, M.E., '14. 935 James St., Syracuse, N. Y.
EDWARDS, JOHN HAROLD, M.E., '14. General Sales Dept., Standard Underground Cable Co. (2) and (3) 600 Westinghouse Bldg., Pittsburgh, Pa. (1) Whitesboro, N. Y.
EDWARDS, KENNETH SCOTT, M.E., '10. Care Proctor & Gamble, Cincinnati, O.
EDWARDS, STANLEY RICHARD, M.E., '03. Editor, *Telephony.* (2) and (3) 347 Monadnock Block, Chicago, Ill. (1) 317 S. Oak Park Ave., Oak Park, Ill. A. I. E. E., Electric Club, Jovian League.
EDWARDS, WEIGHTMAN, '14. Address not known.
EDWARDS, WALTER WALLACE, M.E., '93. The Solvay Process Co., N. Y. 218 Clavimonte Ave., Syracuse, N. Y.
EELLS, HENRY WILSON, M.E., '02. Gen. Supt., Central Maine P. Co. (2) and (3) 311 Water St., Augusta, Me. (1) 97 Stone St., Augusta, Me. A. I. E. E., N. E. L. A., Me. Soc. E. E.
EGBERT, CHARLES COGGILL, M.E., '95. Consulting Engr. (2) and (3) 65 Gluck Bldg., Niagara Falls, N. Y. (1) 404 Jefferson Ave., Niagara Falls, N. Y. A. S. M. E., A. I. E. E.
EGBERT, OSCAR BALDWIN, '04. Address not known.
EGBERT, PERRY TOWNLEY, M.E., '15. 224 Eddy St., Ithaca, N. Y.
EHRET, CORNELIUS DALZELL, M.E., '96. Patent Lawyer. 2116 Land Title Bldg., Philadelphia, Pa.
EHRHART, RAYMOND NELSON, '01. Edgewood Park, Pittsburg, Pa.
EICKEMEYER, CARL, '91. Inventor, 116 Linden St., Yonkers, N. Y.
EIDLITZ, LEOPOLD, M.E., '77. Contracting Engineer. (1) 308 W. 77th St., New York, N. Y. (2) and (3) 110 W. 40th St., New York, N. Y. Engineers Club of N. Y., British Inst. of Naval Architects.
EITEL, EDMUND HENRY, M.E., '07. (1) 222 E. 15 St., Indianapolis, Ind. (2) and (3) Care Bobbs-Merrill Co., Indianapolis, Ind.
EKERN, EMIL ALFRED, M.M.E., '04. Box 1004, Great Falls, Mont.
ELDER, ERNEST E., M.E., '16. 94 Ft. Covington St., Malone, N. Y.
ELDREDGE, ALFRED HENRY, M.E., '88. Consulting Engr. (1) 93 Laurel St., Melrose, Mass. (2) and (3) Care North Packing and Provision Co., Boston, Mass.
ELDREDGE, ERIC GARDNER, '12. 68 Merriman St., Rochester, N. Y.
ELKINS, WILLIAM LUKENS, '94. Address not known.
ELLENBOGEN, SIDNEY ARTHUR, M.E., '08. Member Metric Shirt Co. (2) and (3) Paterson, N. J. (1) 635 Broadway, Paterson, N. J.
ELLENWOOD, FRANK OAKES, A.B., '04. (2) Professor of Heat Power Engr., Sibley College. (1) and (3) 105 Valentine Pl., Ithaca, N. Y. A. S. M. E., Sigma Xi, Am. Asso. for Adv. Sciences.
ELLIOTT, CLARENCE VINCENT, M.E., '11. 216 E. 3 St., Cameron, Mo.
ELLIOTT, WILLIAM SWAN, M.E., '87. Pres. Elliott Co. (2) and (3) 6905 Susquehanna St., Pittsburgh, Pa. (1) 4723 Wallingford St., Pittsburgh, Pa.
ELLIS, JOHN MACEWAN, '03. 111 Broadway, New York, N. Y.
ELLIS, WESLEY ROSE, M.E., '03. Gen. Mgr., Peoples Telephone Co., Geneva, Ohio.
ELLSWORTH, BENJAMIN FRANKLIN, JR., '96. Address not known.
ELLYSON, DOUGLAS WALKER, M.E., '05. (1) 918 Hinman Ave., Evanston, Ill. (2) and (3) Care General Electric Co., Monadnock Bldg., Chicago, Ill.
ELMENDORF, HAROLD HORNBECK, M.E., '14. (2) and (3) Aultman & Taylor Machine Co., Mansfield, O., 174 S. Main St. (1) 317 Elm St., Ithaca, N. Y. A. S. M. E.
ELMENDORF, HUGO M., '17. Ithaca, N. Y.
ELMER, LEWIS STEWART, '93. Manufacturer Yeast, Vinegar and Cider. 2011 Callow Ave., Baltimore, Md.
ELMER, NIXON WILEY, '04. Engr., Lawson Co. (2) 100 Boylston, Boston, Mass. (1) and (3) 106 Greenleaf St., Quincy, Mass. A.S.M.E.
ELMES, CHARLES WARREN, '95. Pres. Charles F. Elmes Eng. Works. Morgan and Fulton Sts., Chicago, Ill.
ELWOOD, JAMES LAWRENCE, M.E., '07. North East, Pa.
ELY, HAROLD FRANKLIN, M.E., '00. Mech. Desig. (2) and (3) Room 710, 140 Cedar St., New York City. (1) 862 Kenmore Pl., Brooklyn, N. Y. Assoc. A. S. M. E.
ELY, WILLIAM GROSVENOR, M.E., '92. Supt. of Construction, G. E. Co. (2) Gen. Elec. Co., Schenectady, N. Y. (1) and (3) 114 Lenox Rd., Schenectady, N. Y. A. S. M. E., A. I. E. E.
EMBREE, CLAYTON JESSE, M.E., '05. Balboa Heights, Canal Zone.
EMENY, FREDERICK JAMES, M.E., '95. (1) 459 E. Green St., Salem, O. (2) and (3) Chief Engineer, Deming Co., Salem, O. A. S. M. E.
EMERICK, LOUIS WARREN, M.E., '91. Pres. 1st Natl. Bank and manufacturing. (2) and (3) 108 Oneida St., Fulton, N. Y. (1) 321 Rochester St., Fulton, N. Y.
EMERSON, EARL ARTHUR, M.E., '10. Distr. Mgr., Am. Rolling Mill, Co. (2) and (3) Monadnock Bldg., San Francisco, Cal. (1) 1546 Alice St., Oakland, Cal.
EMERSON, FILIP LAW, M.E., '06. 128 Henry St., Detroit, Mich.
EMERSON, LUTHER LEE, M.E., '98. 101 Park Ave., New York, N. Y.
EMERY, ALBERT HAMILTON, JR., M.E., '98. Clarks Hill Pl., Stamford, Conn.
EMERY, WILLIAM LORENZO, '97. 43 N. 7th West St., Salt Lake City, Utah.
EMICH, HARRIS CRAWFORD, M.E., '17. P. O. Box 46, Arlington, Md.
EMORY, FREDERICK LINCOLN, M.M.E., '96. Prof. Mechanics and Applied Math., West Virginia Univ. A. S. M. E., S. P. E. E., W. Va. Scientific Soc.
ENDERS, WILLIAM, '97. Benton Harbor, Mich.
ENDRESS, WILLIAM FITZHUGH, '13. 10 Washington Barracks, D. C.
ENGEL, GUSTAVE PHILIP, '09. 335 E. 68 St., New York City.
ENGELHARDT, HENRY, M.E., '13. Import Dept. (1) and (3) Great Northern Hotel, New York City. (2) W. R. Grace & Co., New York City.
ENGLE, CLARENCE FREDERICK, M.E., '08. (1) 67 Park St., Montclair, N. J. (2) and (3) Otis Elevator Co., New York City.
ENGLERT, ALFRED, M.E., '00. Engineer. (1) and (3) 445 75th St., Brooklyn, N. Y. (2) 96 Liberty St., New York City. Care Lidgerwood Mfg. Co. A. S. M. E.
ENGLISH, CLIFTON BENSON, M.E., '01. 646 E. High St., Lexington, Ky.
ENGLISH, GEORGE WILLIAM, '08. 224 E. 7th St., Plainfield, N. J.
ENSLEN, EUGENE FLYNN, JR., M.E., '02. Asst. Elec. Engineer. 2737 Highland Ave., Birmingham, Ala.
ENSIGN, ORVILLE HIRAM, '84. Chief Elec. and Mech. Engr, U. S. Reclamation Service. (2) and (3) 605 Frederick Bldg., Los Angeles, Cal. (1) 903 Oakland Ave., Pasadena, Cal.
ENTWISLE, EDWARD FUSSELL, M.E., '06. Chief Engr., Blast Furnace, Carnegie Steel Co. Duquesne, Pa.
EPLEY, HENRY ERNEST, M.E., '03. Supt. Webster Mfg. Co. 167 Sandusky St., Tiffin, O.
EPSTEIN, HAROLD, M.E., '11. 853 Windham Ave., Cincinnati, O.
ERNSBERGER, MILLARD CLAYTON, '08. Prof. Mech. Eng., Rochester Univ., Univ. Rochester, 12 Birch Crescent, Rochester, N. Y. A. S. M. E., Rochester Eng. Soc.
ERWIN, JAMES ARAD, M.E., '07. 6212 Randolph St., Oak Park, Ill.
ERISMAN, OSCAR, M.E., '97. 23 Glenwood Blvd., Schenectady, N. Y.
ERWIN, GEORGE LEMUEL, JR., M.E., '17. Kalamazoo, Mich.
ESCATO, CHARLES JOSE, '06. Address not known.
ESHELMAN, CHARLES METZ, M.E., '98. (2) Care Cameron Machine Co., 61 Poplar St., Brooklyn, N. Y. (1) and (3) Cresskill, N. J.
ESMOND, NATHAN, M.E., '08. Valley Falls, N. Y.
ESPENSCHIED, FREDERICK FAIRFAX, JR., M.E., '05. Engineer. (1) and (3) 16 Bigger Ave., Toronto, Ont. (2) Hydro Electric Power Commission of Ont. Asst. A. I. E. E.
ESPINDOLA, DARIO, M.E., '11. Paraquar 1031. Buenos Aires, Arg. Rep. S. A.
ESTABROOK, FRED J., M.E., '16. Odessa, N. Y. A. S. M. E.
ESTILL, GEORGE CASTLEMAN, M.E., '07. B. R. Lt. & Power Co., Birmingham, Ala.

ETHERIDGE, Charles Locke, M.E., '91. (1) 6926 Olcott Ave., Chicago, Ill. (2) and (3) 1001 Hunter Bldg., Chicago, Ill.
ETSHOKIN, Louis, M.E., '17 A.B. Kewanee, Ill. A. I. E. E.
EUSTIS, Truman William, M.E., '09. Salesman, G. E. Co. (2) and (3) Electric Bldg., Butte, Montana. (1) Hinsdale, Ill. A. I. E. E.
EVANS, Arad Ward, M.E., '93. Evans Bldg., Washington, D. C.
EVANS, Cornelius Henry, M.E., '13. (1) 418 Warren St., Hudson, N. Y. (2) and (3) Care C. H. Evans & Sons, Hudson, N. Y.
EVANS, Clarence Judd, M.E., '12. Univ. Club, Salt Lake City, Utah.
EVANS, Chester Willard, '03. Sec. C. H. Evans & Co. (2) and (3) 187 Fremont St., San Francisco, Cal. (1) 2419 Washington St., San Francisco, Cal.
EVANS, Frysinger, '96. Care Daisy Mining Syndicate, Goldfield, Nev.
EVANS, George Edward, M.E., '11. (1) and (3) 375 W. Market St., York, Pa. (2) York Mfg. Co., York, Pa.
EVANS, Gordon Maynard, M.E., '06. 248 Hague Ave., Detroit, Mich.
EVANS, Leigh Rodenbough, M.E., '07. Chief Engr., Russell Motor Car Co. Russell Motor Car Co., Toronto, Can.
EVANS, Martin Edward, M.M.E., '11. Chebanse, Ill.
EVANS, Mason, jr., M.E., '14. (1) 215 Lincoln Ave., Youngstown, O. (2) and (3) The Youngstown Iron and Steel Co., Youngstown, O.
EVANS, Walter Hubert, M.E.,'06. Northern Elec. Co., Sacramento, Cal.
EVANS, Wilber Forbes, M.E., '93. Treas. and Mgr. Elec. Maintenance Co. (1) 149 Pearl St., Boston, Mass. (2) and (3) 15 Wharf St., Boston, Mass.
EVELAND, Frank Winsor, '05. Gen. Mgr., Yerkes Eveland Co. (2) and (3) 615 N. Broad St., Philadelphia, Pa. (1) 6307 Sherwood Rd., Philadelphia, Pa.
EVERINGHAM, Charles, '13. 409 E. Main St., Robinson, Ill.
EVERSON, Charles Wetmore, M.E., '04. (1) 17 Clarendon Pl., Orange, N. J. (2) and (3) 79 Chambers St., New York City.
EVERSON, William Winton, '95. 307 E. Colorado St., Pasadena, Cal.
EWING, John Jackson, M.E., '90. Chesapeake & Ohio R. R. Co. Box 296, Richmond, Va.
FABEL, Frederick Charles, '96. Supt. (2) and (3) American Oak Leather Co., Cincinnati, O. (1) 2484 Observatory Ave., Cincinnati, O.
FABIAN, Francis Gordon, M.E., '05. (1) and (3) 1462 Wesley Ave., Evanston, Ill. (2) Chicago Unoin Station Co., 521 W. Adams St., Chicago, Ill. Am. Inst. Mining Engineers.
FAILE, Edward Hall, M.E., '06. Bldg. Constr. Engineering. (3) Cornell Club, 165 Park Ave., New York City. A. S. M. E., Royal Soc. of Arts of England, Am. Ass. for Advancement of Science, Merchants Ass. of New York.
FAILOR, Newton Cowan, M.E., '06. The U. S. Purchasing Co. (1) Richmond Hill, Queens Co., N. Y. (2) and (3) Woolworth Bldg., New York City.
FAIR, Thomas Hardy, '96. Room 1402, 60 Wall St., New York City.
FAIRBANKS, Frank Latta, M.E., '10. Pendleton, Ore.
FAIRBANK, Harvey Clark, M.E., '05. Commercial Engr., Turbine Sales Dept. (2) and (3) General Elec. Co., Schenectady, N. Y. (1) 5 Lexington Ave., Schenectady, N. Y.
FALKENAU, Arthur, B.M.E., '78. Vice-Pres. Hooper-Falkenau Eng. Co. (2) and (3) Woolworth Bldg., New York City. (1) 911 Park Ave., New York City. Tau Beta Pi, A. S. M. E., Eng. Club of Phila., Franklin Inst.
FALKENAU, Robert Morris, '05. (1) 1 Edgewood Park, New Rochelle, N. Y. (2) and (3) Mgr. of C. D. Jackson & Co., Marble Importers, New York City.
FANCHER, Arthur McGraw, M.E.,'11. 15½ Bigelow St., Binghamton, N.Y.
FANCK, Louis Oscar, M.E., '98. 7 Main St., Lockport, N. Y.
FARKELL, George C., M.E., '92. 1307 Middle Ave., Elyria, O.
FARLEY, Otis Lord, '10. 550 Center St., Newton, Mass.
FARMER Frank Malcolm, M.E., '99. 80 St. and East End Ave., New York, N. Y.
FARMER, Thomas, M.E., '05. Vice-Pres. Consolated Car Heating Co. of Albany, N. Y.
FARNHAM, Frank Skinner, '05. Telephone Engineer. (1) 112 Crest Road, Wellesley, Mass. (2) and (3) New England Telephone & Telegraph Co., Boston, Mass.
FARNHAM, George Bradford, '05. 43 Cottage St., Wellesley, Mass.
FARNHAM, Sidney Wilkin, M.E., '94. 4938 Washington Park Court, Chicago, Ill.
FARNSWORTH, Frederick Clarkson, '15. 800 Riverside Drive, New York City.
FARRINGTON, Thomas Hinchman, M.E., '10. Eng. and Contr. (1) (2) and (3) Owego, Tioga Co., N. Y. A. S. M. E.
FARRIOR, James William, M.E., '07. Kenansville, N. C.
FAULKNER, William Willis, '94. 240 Morgan St., Tonawanda, N. Y.
FAWELL, Joseph Edward, '09. 5598 Baum St., Pittsburg, Pa.
FAY, Edward Miller, M.E., '09. Commercial Engineer. (1) 90 Cory Rd., Brookline, Mass. (2) and (3) Westinghouse Electric & Mfg. Co. 10 High St., Boston, Mass. Natl. Elec. Light Society.
FENTON, Paul W., '15. Chief Chemist. (1) 502 W. 143 St., New York City. (2) and (3) Hughes Tool Co., Houston, Texas. A. S. M. E.
FENIO, George F., M.E., '06. Sales Mgr., The Richardson-Phinx Co. (2) and (3) 122 Reservoir Ave., Milwaukee, Wis. (1) 545 Stowell Ave., Milwaukee, Wis. A. I. E. E.
FERBSTEIN, Sidney Joy, M.E., '13. 271 W. Market St., Akron, O.
FERGURSON, Arthur E., M.E., '05. 706 2d Ave., Cedar Rapids, Iowa.
FERGUSON, Clinton Brooks, M.E., '12. Care Cutler Hammer Co., 77 Franklin St., Boston, Mass.
FERGUSON, Hugh McKnight, M.E., '03. 414 Edith St., Missoula, Mont.
FERGUSON, John Alfred, M.E., '07. Merrit-Ferguson Const. Co., 415 Ft. Washington Ave., New York City.
FERGUSON, John Robert, M.E., '03. 402-27th Ave., Milwaukee, Wis.
FERNALD, Ernest Mercer, M.E., '15. (1) 550 Sheperd St., Washington, D. C. (2) and (3) Remington Arms, V. M. C. Co., Bridgeport, Conn.
FERRAS, John Mason, M.E., '16. 132 S. First Ave., Mt. Vernon, N. Y.
FERRIS, J. M., M.E., '16. 76 Young Ave., Pelham, N. Y.
FERRIS, LeRoy, '18. Mgr. Stock Dept. (1) and (3) 4 Howard Ave., White Plains, N. Y. (2) Packard Motor Car Co., Mamaroneck and Martine Aves., White Plains, N. Y. Alpha Chi Rho.
FERRIS, William Robert, M.E., '11. 165 Mt. Vernon Ave., Detroit, Mich.
FIELD, Arthur Carpenter, M.E., '91. Woolen Commission. (2) and (3) 206 S. Market St., Chicago, Ill. (1) 838 N. Dearborn St., Chicago, Ill.
FILBERT, George B., M.E., '12. Sales Engr., Diehl Mfg. Co. (2) and (3) 90 Prince St., New York City. (1) 2508 St. Paul St., Baltimore, Md.
FILLEBROWN, Carter, M.E., '16. Fore River Ship Building Corp. 37 Harris St., Brookline, Mass.
FINCH, Herbert Isaac, M.E., '96. Chief Engr. and Supt., The Emerson Elec. Mfg. Co., 6240 McPherson Ave., St. Louis, Mo. A. I. E. E.
FINLEY, Albert Clarke, M.E., '12. 108 Park St., Buffalo, N. Y.
FISH, J. A., M.E., '12. Sales Mgr. (2) and (3) Care Cydemotor Corp., 520 Arlington Bldg., Rochester, N. Y. (1) 822 Frost Ave., Rochester, N. Y. S. A. E.
FISHER, Arine Wallace, M.E., '14. 1039 Belmont Pl., Seattle, Wash.
FITZ, Arthur, M.E., '10. Master Mechanic, American Clay Products Co. (1) Southampton, N. Y. (2) and (3) P. O. Box 155, South River, N. J.
FITZPATRICK, Walter J., '97. Engr. Exam. Publ. Serv. Comm., 2d Dist. (2) and (3) Albany, N. Y. (1) 734 Fifth Ave., Watervliet, N. Y. A. I. E. E.
FLEMING, Robt. Fleming, M.E., '10. Sterrett & Fleming, Champlain Ave. and Kalorama Rd., Washington, D. C.
FLETCHER, Ernest Sylvester, M.E., '05. Asst. Gen. Mgr. (1) 4022 Junius St., Dallas, Tex. (2) and (3) Tex. Power & Light Co., Dallas, Tex. Executive Committee of Southwestern Gas & Elec. Assn., A. I. E. E., National Elec. Light Assn.
FLETCHER, Frederick Charles, '94. (1) 34 Philbrick Rd., Brookline, Mass. (2) and (3) Treas. Pocasset Worsted Co.
FLETCHER, Harold Wheelock, M.E., '15. Chief Engineer. (1) 4691 Beaufort St., Richmond Hill, L. I. (2) and (3) Hughes Tool Co., Houston, Tex. Sigma Xi, A. S. M. E.
FLETCHER, Wm. Gould, M.E., '10. 366 12 Ave., Paterson, N. J.
FLICKINGER, Walter Eugene, M.E., '08. (1) 190 Pingree St., Detroit, Mich. (2) and (3) 510 Farwell Bldg.
FLINN, Rufus Hill, M.E., '09. Gen. Foreman, Bradford Shops. (2) and (3) Care P. C. Co. St. L. Ry., Bradford, Ohio. (1) 431 Haddon Ave., Camden, N. J.
FLINT, Ralph Norton, M.E., '94. Lawyer in Patent Causes. (1) 129 Walnut St., Montclair, N. J. (2) and (3) 2 Rector St., New York City.
FLINT, Rufus, M.E., '87. Prof. Managua, Nicaragua, C. A.
FLOOD, Henry, jr., M.E., '09. Pa. Central Lt. & Power Co., Altoona, Pa.
FLORIAN, Julian A., '03. (1) Box 849, Plantsville, Conn. (2) and (3) 141 W. 116 St., New York City.
FLORY, Burton Pughe, M.E., '95. Supt. Motive Power. N. Y. O. & W. Ry., Middletown, N. Y.
FLOWERS, Alan Estis, M.E., '02, M.M.E., '14, Ph.D., '15. Professor of Electrical Engineering. (1) 1634 Neil Ave., Columbus, Ohio. (2 and (3) Ohio State Univ., Columbus, O. A. I. E. E., A. S. M. E., Am. Soc. for Test Materials, Am. Electrochemical Soc., Ill. Eng. Society, Am. Phys. Soc., Ohio Soc. of Mec. Elec. and Steam Eng., Sigma Xi, Tau Beta Pi.
FLYNN, Chas. Andrew, M.E., '05. Supt. and Elec. Engineer. Park Row Bldg., New York, N. Y.
FOCKÉ, Eberhard Joseph, '97. Law Clerk. 707 E. 2 St., Brooklyn, N. Y.
FOGG, Walter Strokes, M.E., '12. 1909 Mt. Vernon St., Philadelphia, Pa. Engrs. Club of Philadelphia.
FOLGER, Roy Cook, M.E., '08. Rep. and Maintenance Al. Co. of America, Massena, N. Y. Assoc. A. I. E. E.
FOLLETT, Harold Leonard, '11. 246 Columbia St., Adams, Mass.
FOOTA, H. B., M.E., '04. Engr., Kellogg Toasted Corn Flake Co., Battle Creek, Mich. A. I. E. E.
FORGY, J. E., M.E., '06. Purch. Engr., Chas. Warner Co. (2) and (3) 10th and King Sts., Wilmington, Del. (1) 1618 Franklin St., Wilmington, Del. A. S. M. E.
FORSHEE, Isaac C., M.E., '05. Elec. Engr., Office Supt. Tel., P. R. R. (2) and (3) Broad St. Station, Philadelphia, Pa. (1) 443 W. Penn St., Germantown, Pa. A. I. E. E.
FRANCIS, Daniel Robert, M.E., B.A., '09. Coniston Ave., Waterbury, Conn.
FRANK, Wm. K., M.E., '11. Vice-Pres. Damascus Bronze Co. (1) 928 South Ave., Pittsburgh, Pa. (2) and (3) 5656 Beacon St., Engr. Soc. W. Va., Br. Inst. Metals, Am. Chem. Soc., Am. Soc. Testing Materials.
FRANKE, Chas. A., M.E., '11. Sec. Treas. Auburn Ignition Mfg. Co. (2) and (3) Franklin St., Auburn, N. Y. (1) 7 Tuxill Square, Auburn, N. Y.
FRANKLIN, Paul Arnold, M.E., '13. Supt. Trenton W'House American Sanitary Works. (2) Trenton, N. J. (3) and (1) 84 North Clinton Ave., Trenton, N. J. A. S. M. E.
FREEMAN, P. A., M.E., '16. Box 65, Weedham, N. J.
FRITCHIE, A. F., M.E., '16. Stidell, La.
FRITZ, Emanuel, M.E., '08, M.F. (Yale), '14. Forest Assistant, U. S. Forest Service. (1) Baltimore, Md. (2) and (3) Fort Valley Experiment Station, Flagstaff, Ariz. Sigma Xi.
FRY, Jack Ruth, M.E., '15. Western Elec., New York, N. Y.
FULLER, Leonard F., M.E., '12. Chief Elec. Eng. and Radio Eng. (1) 1357 Cowper St., Palo Alto, Cal. (2) and (3) Federal Telegraph Co., San Francisco, Cal. A. I. E. E., Inst. Radio Engrs.
FUNNELL, Charles Loomis, M.E., '16. Editorial Staff, Electrical Merchandising. (1) 2 Washington Ave., Hastings-on-Hudson, N. Y. (2) and (3) 239 W. 39th St., New York City. A. I. E. E.
GABAY, Harry Rutherford, M.E., '97. 15 Dey St., New York, N. Y.
GABLE, Ward Llewellyn, M.E., '10. Sharon, Pa.
GAEHR, David, M.E., '01. Designing and Contracting Engineer. (1) 1836 Wilton Rd., Cleveland Heights, Ohio. (2) and (3) 950-2 Rockefeller Bldg., Cleveland, O. A. S. M. E., Cleveland Eng. Society.
GAENSSLEN, Carl August, M.E., '06. 655 Roscoe St., Lake View Station, Chicago, Ill.
GAGE, Asahel Willey, '99. Lawyer. (2) and (3) 1311 Hartford Bldg., Chicago, Ill. (1) 1134 Elmwood Ave., Wilmette, Ill.
GAGE, Edward Ballard, M.E., '95. Ostburg, Wis.
GAGE, Victor R., M.E., '06, M.M.E., '11. Asst. Prof. Engrg., Cornell University. (2) Sibley College, Cornell University. (1) and (3) 119 Heights Court, Ithaca, N. Y. A. S. M. E.
GAHUKIN, Valentine Gregory, M.E., '16. 615 N. Aurora St., Ithaca, N. Y. A. I. E. E.
GAIL, Clarence Wallace, M.E., '97. 810 Penobscot Bldg., Detroit, Mich.
GAIL, Geo. Wm., jr., M.E., '16. Tudor Hill Apts., Baltimore, Md. S. A. E.
GAIL, Harry Merton, M.E., '02. 1010 Mutual Life Bldg., Buffalo, N. Y.
GAILEY, Austen, M.E., '11. 15 Dey St., New York, N. Y.
GAINES, Frederic Freelinghuysen, M.E., '95. 208 N. 26 St., Savannah, Ga.
GALBREATH, Louis Julian, M.E., '17. 795 E. 19th St., Brooklyn, N. Y.
GALLAGHER, Wm. H., M.E., '06. Elec. and Mec. Eng. (1) Caro, Mich. (2) and (3) Mohawk & Wolverine Copper Co., Kearsarge, Mich.
GARBARINO, Joseph Andrew, M.E., '17. Midvale, N. J.
GASS, Karl William, M.E., '12. (2) and (3) The Fort Pitt Engr. Co., Oliver Bldg., Pittsburgh, Pa. (1) 125 Stratford Ave., Pittsburgh, Pa.
GATES, Grandon D., M.E., '09. Chief Draftsman, The Celluloid Co., 290 Ferry St., Newark, N. J. A. S. M. E.
GATES, John George, M.E., '17. (1) and (3) 31 Stewart St., E. N. Y. Brooklyn, N. Y. (2) Sperry Gyroscope Co., Brooklyn, N. Y. Eta Kappa Nu, Tau Beta Pi, A. I. E. E.
GEHR, Ray Stuart, M.E., '06. Patent Lawyer. (1) 128 Maryland Ave., S. W., Washington, D. C. (2) and (3) Ouray Bldg., Washington, D. C. Sigma Xi.
GERMOND, Russell Clark, M.E., '09. (2) and (3) Asst. Supt., Stanley Works, Cold Rolled Steel Mill, New Britain, Conn. (1) 343 Hart St., New Britain, Conn.
GHERARDI, Bancroft, M.E., '93, M.M.E., '94. Electrical Plant Engineer. (1) Summer Bay Head, N. J. Winter, 142 East 38th St., New York City. (2) and (3) 195 Broadway, New York City. A. I. E. E., Franklin Inst., A. S. M. E., N. Y. Electrical Society, Sigma Xi, Engineers Club.
GILCREAST, Webster Farnham, M.E., '07. 67 W. Chestnut St., Wakefield, Mass.
GILDNER, Harry Holmes, '07. 21 Overlook St., Mt. Vernon, N. Y.
GILES, George Stewart, M.E., '12. Carolina Mineral Co., Penland, N. C.
GILKESON, Fairbairn, '14. 1421 Arch St., Philadelphia, Pa.
GILLELAND, Pierre Hall, '08. Mech. Engr. 1327 Church St., Evanston, Ill.
GILL, Calvert Burke, '06. 125 Asquith St., Baltimore, Md.

GILLET, LANGDON, '09. 158 E. 38th St., New York City.
GILLETTE, WILLIAM DEWITT, '07. 724 N. Central Ave., Chicago, Ill.
GILLESPIE, CLARENCE LESTER, M.E., '03. 3212 Ave. O., Galveston, Tex.
GILLESPIE, EARL CURTISS, '12. Huntington, L. I., N. Y.
GILLIES, WILLIAM BROWNE, M.E., '04. (1) 7221 Luella Ave., S. Chicago, Ill. (2) and (3) Illinois Steel Co., S. Chicago, Ill.
GILLIS, ALBERT RUFUS, B.M.E., '75. 307 Emerson Ave., Syracuse, N. Y.
GILLMORE, Q. A., '16. 16425 Hilliard Rd., Lakewood, Ohio.
GILMORE, CHARLES THOMAS, '09. Portland Electrical Co. 121 Center St., Portland, Me.
GILSON, EMERY GRAVES, M.E., '94. Machias, Me.
GIMPER, EARLE H., '02. Atrus Belt Gas Co., Corona, Cal.
GINORIO, FRANCISCO RICARDO, M.E., '07. Las Delicias, Clariente, Cuba.
GINTER, MORDE EMMONS, '07. 223 E. Long Ave., Du Bois, Pa.
GIVENS, HARRISON CRANDALL, M.E., '01. Director of Industrial and Applied Arts. (1) 1805 S. Broadway, Pittsburg, Kan. (2) and (3) State Manual Training Normal, Pittsburg, Kan. Natl. Soc. for Promotion Ind. Education, Western Drawing and Manual Training Ass., Kansas Academy of Science, Kansas Chamber of Commerce.
GLADDEN, CHARLES STEPHEN, M.E., '00. Mechanical Engineer. (1) 80 N. Franklin St., Wilmington, Del. (2) and (3) Room 866 Du Pont Bldg., Wilmington, Del. A. S. M. E.
GLASGOW, CARR LANE, M.E., '02. 4918 McPherson Ave., St. Louis, Mo.
GLEASON, ANDREW CHASE, '97. 215 Oxford St., Rochester, N. Y.
GLEASON, DANIEL HOYT, M.E., '14. 4 Taylor Ave., S. Norwalk, Conn.
GLEASON, JAMES EMMETT, '92. 31 Portsmouth Terrace, Rochester, N. Y.
GLEASON, WALTER BURRELL, '11. Atty. at Law. (2) and (3) 2-3 Mulkey Bldg., Portland, Ore. (1) 572 Weidler St.
GLENN, JESSIE YOUNG, M.E., '98. Mechanical Engineer. (2) and (3) Canadian Con. and Foundry Co., Montreal, Can. (1) 429 Grosvenor Ave., Westmount, Montreal, Canada. Canadian Ry. Club.
GLENNIE, ROBERT DOUGLAS, M.E., '08. Salesman. (1) and (3) 39 Roebling Pl., Niagara Falls, N. Y. (2) Gen. Elec. Co., Niagara Falls, N. Y. American Electrochemical Society.
GLOVER, ARTHUR, M.E., '08. 1833 Clinton Ave., Bronx, New York City, N. Y.
GLOVER, CHARLES NICOLL, '04. Washingtonville, N. Y.
GLOVER, KENNETH GRAHAM, M.E., '97. 92 Greene Ave., Brooklyn, N. Y.
GOAN, PERCIVAL, M.E., '13. 2711 2d Ave. N., Billings, Mont.
GOBEL, FRANK CONANT, M.E., '03. Valley Stream, L. I., N. Y.
GODBOLD, WARREN ARTHUR, '11. Tropical Agriculture. Box C, Ancon, Canal Zone.
GODDARD, JOSEPH STERLING, M.E., '94. 332 S. Michigan Ave., Chicago, Ill.
GODFREY, JOHN HANES, M.E., '95. Trumansburg, N. Y.
GOERTZ, WALTER AUGUST, M.E., '14. 793 High St., Newark, N. J.
GOETTSCH, JULIUS, M.E., '04. (1) 315 N. Grove St., Oak Park, Ill. (2) and (3) D. H. Burnham & Co., Chicago, Ill.
GOETZ, WERNER W., M.E., '11. Sales Engineer. Cutler-Hammer Mfg. Co., 1201 Chestnut St., Philadelphia, Pa. A. I. E. E., Engrg. Club of Philadelphia, A. S. E. E.
GOFF, WILLIAM FREDERICK, '09. 89 Aldine St., Rochester, N. Y.
GOLDBERG, MONROE SAUL, M.E., '10. President Northern Waterproofing Co. (2) and (3) 195 Lexington Ave., New York City. (1) 420 Riverside Drive, New York City. A. S. M. E.
GOLDBERG, S., M.E., '16. 567 Ave. C, Bayonne, N. J.
GOLDEN, NELSON GARLOCK, '17. R. F. D. 1, Schenectady, N. Y.
GOLDMAN, BENJAMIN PAUL, M.E., '14. 199 Reid Ave., Brooklyn, N. Y.
GOLDSBOROUGH, WINDER ELWELL, M.E., '92. Consulting Engineer. (1) Norwalk, Conn. (2) and (3) 52 Vanderbilt Ave., New York City. A. S. M. E., Natl. Institute of Social Science, Fellow A. I. E. E.
GOLDSMITH, EDWIN, '94. 157 W. 85th St., New York City.
GOLDSMITH, GUSTAVE MOSLER, M.E., '05. Mosler Safe Co., Hamilton, O.
GOLDSMITH, WILLIAM MOSLER, M.E., '09. Goldsmith Metal Lath Co., Cincinnati, O.
GOLDSTEIN, ISAAC MONTIFOR, M.E., '07. Milford, Ill.
GOLDWATER, SIDNEY JAMES, M.E., '04. 2671 3 Ave., New York, N. Y.
GOLL, WALTER SCOTT, M.E., '96. Commercial Engineer. (1) Anthony Hotel, Ft. Wayne, Ind. (2) and (3) Gen. Electric Co., Ft. Wayne, Ind. Commercial Club of Ft. Wayne.
GOMEZ, JULIO, '00. Rosario, Aguacate, Cuba.
GOMPH, CLARENCE JEREMIAH, M.E., '02. 520 State St., Utica, N. Y.
GONÇALVES, DARIO RODRIGUES, M.E., '14. Guaratinguetí, Sao Paulo, Brazil.
GOOCH, EVERETT PASEY, M.E., '14. (1) Brightwaters, L. I. (2) and (3) Westinghouse Elec. and Mfg. Co., E. Pittsburg, Pa.
GOODE, WILLIAM FRANCIS, '05. Pontiac, Ill.
GOODIER, CHESTER JENNINGS, M.E., '07. Port Townsend, Wash.
GOODIER, HOMER WADSWORTH, M.E., '16. Cayuga Cement Corp'n, Portland Point, N. Y. Portland Point, N. Y. A. S. M. E.
GOODMAN, JAMES FRANKLIN, M.E., '99. Partner in Mercantile Business. (2) and (3) 510 Keith and Perry Bldg., Kansas City, Mo. (1) 3633 Central St., Kansas City, Mo. Sigma Xi.
GOODMAN, TIMOTHY SEYMOUR, '08. 115 Ludlow St., Hamilton, O.
GOODMAN, WILLIAM EDWARD, M.E., '17. 5753 Woodlawn Ave., Chicago, Ill.
GOODSPEED, CHARLES BENNETT, M.E., '08. 619 Ry. Exch. Bldg., Chicago, Ill.
GOODWILLIE, DAVID HERRICK, M.E., '08. Director of Public Service of Toledo. 223 Valentine Bldg., Toledo, Ohio.
GOODRICH, LESLIE WELLES, '99. Glastonbury, Conn.
GOODWIN, GEORGE SAMUEL, M.E., '99. 741 25 St., Moline, Ill.
GOODWIN, FRANK FAIRFIELD, M.E., '90. 1464 Lexington Ave., New York N. Y.
GOODWIN, PHILLIP JAMES, M.E., '08. 1563 Lee St., Charlestown, W. Va.
GORBY, CHARLES BARON, '96. Treas. Columbia Stamping and Enameling Works, Terre Haute, Ind.
GORDON, GEORGE HUNTLEY, M.E., '05. Major 4th Div., Ammunition Subpark A. S. C., C. E. F. (3) Care Army Post Office, London, Eng. (2) The J. Bertman Co., Dundas, Ont. (1) Principal's House, Queens Univ., Kingston, Ont.
GORDON, ROBERT LOUDON, M.E., '95. 170 Broadway, New York, N. Y.
GORDON, THOMAS CROXTON, M.E., '06. 310 E. Grace St., Richmond, Va.
GORDON, WILLIAM ALEXANDER, M.E., '96. Shelton, Conn.
GORDON, WILLIAM, '99. Care Birmingham Iron Fdry., Derby, Conn. (1) Box 563, Shelton, Conn.
GORMAN, NEIL ARCHIBALD, M.E., '16. 26 Broadway, New York City.
GORRELL, JOHN STACY, '05. Telephone Engr., Chesapeake & Potomac Tel. Co. (2) and (3) 108 East Lexington St., Baltimore, Md. (1) 1312 Harlem Ave., Baltimore, Md. Telephone Soc. Baltimore.
GOREE, CHURCHILL POMEROY, JR., '13. 312 K St., South Boston, Mass.
GOTTSBERGER, JAMES BANKER, '99. Address not known.
GOTTSCHALK, LIONEL JOHN, '09. Address not known.
GOULD, ARCHIE BAXTER, '00. 700 Central Ave., Cleveland, O.
GOULD, CLARENCE ALLEN, '07. (1) and (3) 111 State St., Seneca Falls, N. Y. (2) D. Nostrand Co., 24 Park Place, New York City.
GOULD, DAVID JAMES, JR., '10. 256 Bard Ave., W. New Brighton, N. Y.
GOULD, JOHN HOWARD, M.E., '06. 420 High St., Lansing, Mich.
GOULD, LAWRENCE EBENEZER, M.E., '01. Industrial Editor. (1) 5957 Kenmore Ave., Chicago, Ill. (2) and (3) Electric Railway Journal, 37 W. Van Buren St., Chicago. A. I. E. E., Vice-Pres., and Treas. of Am. Elec. Ry. Mfgrs. Assn., Chicago Engineers Club.
GOULD, NORMAN JUDD, M.E., '99. Pres. Gould Mfg. Co., Seneca Falls, N. Y.
GOULD, SEABURY SMITH, JR., '11. Asst. Treas., Goulds Mfg. Co. Seneca Falls, N. Y.
GOWLING LAWRENCE EDWARD, M.E., '11. Lighting Supt. (1) 316 E. Seneca St., Ithaca, N. Y. (2) and (3) Ponce Ry. Lt. Co., Ponce, P. R.
GOWDY, EARL COREY, '11. Baggageman. (1) (2) (3) N. Y. C. & H. R. R. Station, Syracuse, N. Y.
GRAEF, H. H., JR., M.E., '16. 89 Charlotte St., Akron, O.
GRAFF, JOHN THEODORE, M.E., '00. Division Plant Engineer. (1) 207 S. St. N. E., Washington, D. C. (2) and (3) The Chesapeake and Potomac Tel. Co., 5 Light St., Baltimore, Md.
GRAFF, THOMAS EWING, '96. P. O. Box 578, Pittsburg, Pa.
GRAHAM, ROBERT W., E.E., N. Dak. '13, M.E., Cornell '15. Instructor in Elec. Engr., 3 Central Ave., Carrington, N. D.
GRAMBOW, MAX AUGUST, M.E., '12. 410 Andrews Bldg., Cincinnati, O.
GRANT, ALBERT WESTON, JR., M.E., '09. Operating Dept. (1) 34 Thorn St., Sewickley, Pa. (2) and (3) H. Koppeas Co., Union Arcade, Pittsburgh, Pa. A. S. M. E., A. G. I., I. E. S.
GRANT, FRANK LINCOLN, '10. Address not known.
GRANT, HENRY WILLIAM, M.E., '12. Elec. Engr. Roadmaster. (2) and (3) Pacific Northwest Traction Co. (1) 214 Flira St., Bellingham, Wash. M.M.E.
GRANT, JAMES DENISON, M.E., '09. Instr. McCormick Works Shop School. (2) and (3) I. H. Co. of N. J. McCormick Wks., Western and Blue Is. Aves., Chicago, Ill. (1) 3650 S. Leavitt St., Chicago, Ill.
GRANT, JOHN MACDONALD, M.E., '11. Australian Signal Corps., Melbourne, Australia.
GRANT, RODERICK DAVID, M.E., '03. 2146 Cornell Rd., Cleveland, O.
GRANTIER, LESLIE VERNE, M.E., '01. B. & O. R. R., 230 Trowbridge St., Pittsburg, Pa.
GRAVES, HALSEY ROGERS, M.E., '91. Salesman. Au Sable Forks, N. Y.
GRAVES, RALPH IRISON, M.E., '07. (1) 1707 Ridge Ave., Evanston, Ill.
GRAY, CLYDE D., M.E., '00, M.M.E., '01. Elec. Eng., J. G. White Eng'g Corp. (2) and (3) 43 Exchange Place, New York City. (1) 227 Highbrook Ave., Pelham, N. Y. The Engineers Club, A. I. E. E., N. E. L. A., N. Y. E. S., A. S. T. M., Sigma Xi.
GRAY, FRED RAMSEY, M.E., '10. Erection Engr., Westinghouse Elec. Co. (2) 467 Tenth Ave., New York City. (1) and (3) 473 W. 158 St., New York City.
GRAY, J. A., M.E., '16. 2733 E. 76 St., Chicago, Ill.
GRAY, JOHN WILSON, '91. (1) 430 S. 45th St., Philadelphia, Pa. (2) and (3) Newport News Shipbldg. and Drydock Co., 410 Harrison Bldg., Philadelphia, Pa.
GRAY, LESLIE JACKSON, M.E., '96. 828 Frick Bldg., Pittsburg, Pa.
GRAY, WILLIAM EMERY, '87. Care Enamel Pipe and Eng. Co., Elyria, O.
GRAYSON, ALFRED CLARK, M.E., '14. 2966 Briggs Ave., New York, N. Y.
GREEN, ANDREW HEATLY, M.E., '92. Solvay Process Co., Detroit, Mich.
GREEN, CARL MELVILLE, M.E., '93. Care Treas. Dept. Revenue Cutter Serv., Washington, D. C.
GREEN, HEATLY, M.E., '01. 375 Montclair Ave., Detroit, Mich.
GREEN, J. BIRCHARD, M.E., '09. Mfgr. Steel Wires. (1) 1620 E. 55th St., Chicago, Ill. (2) and (3) 103d St. and Torrence Ave., Chicago, Ill.
GREEN, JOHN ORNE, M.E., '15. 1024 Noble Ave., Bridgeport, Conn. With Remington Arms Co.
GREEN, JONATHAN SHERMAN, '96. Lawyer. Westinghouse Machine Co., E. Pittsburgh, Pa.
GREEN, LLOYD FRANCIS, M.E., '13. Spring Ave., Ridgewood, N. J.
GREEN, MORRIS MILLER, M.E., '94. Address not known.
GREEN, THORNTON ATKINS, '96. Capitalist, Lands and Lumber. Ontonagon, Mich.
GREEN, W. S., '16. 1211 Aston St., Chicago, Ill.
GREENAWALT, JOHN E., M.E., '90. Metallurgist & Electro Chemist. 39 E. 42d St., New York City.
GREENBERG, MAX, M.E., '06. Care Intl. Pump Co. 115 Broadway, New York, N. Y.
GREENE, DAVID JOY, M.E., '95. Sec. and Treas. Milford Ice Co. (2) and (3) 37 River St., Milford, Conn. (1) 13 Pond St., Milford, Conn.
GREENE, GEORGE DE BOKETON, M.E., '93. 43 Exchange Pl., New York, N. Y.
GREENE, GEORGE VICTOR, '95. Salesman for Cannon Mills of Philadelphia. 10 Stewart St., Amsterdam, N. Y.
GREENWOOD, HARLEY, '72. Farmington, Me.
GREER, EDWARD RUSSELL, M.E., '08. 2629 Pleasant Ave., Minneapolis, Minn.
GREER, EVERETT SIDNEY, M.E., '14. Hazel Atlas Glass Co., Washington, Pa.
GREGG, ROBERT, M.E., '06. (1) 176 Capitol Ave., Atlanta, Ga. (3) Box 1066, Atlanta, Ga.
GREGORY, MAXWELL DELOS, '09. Unadilla, N. Y.
GREGORY, WILLIAM BENJAMIN, M.E., '94, M.M.E., '08. Prof. of Exp. Eng., also Irrigation Engr. (2) and (3) Tulane University, New Orleans, La. (1) 630 Pine St., New Orleans, La. A. S. M. E., A. S. C. E., Sigma Xi, La. Eng. Soc., Soc. Prom. of Eng. Education, N. O. Acad. of Sciences.
GREGSON, EDWARD JESSE, M.E., '06. Enlisted in Canadian Reg. 228 Liberty St., Schenectady, N. Y.
GREUTER, RUDOLPH ERNST, M.E., '17. 1886 Huron Ave., Cincinnati, O.
GRIDLEY, SIDNEY DIAS, M.E., '08, M.M.E., '09. Sales Engr., Elect. Storage Batt. Co. (2) 19th and Allegheny Ave., Philadelphia, Pa. (3) and (1) 5418 Walnut St. Philadelphia, Pa. Elec. Vehicle Ass.
GRIFFIN, HARRY WARREN, M.E., '96. Mfg. Sec. and Treas. (2) and (3) Taylor, Stiles, and Co. (1) Riegelsville, N. J.
GRIFFITHS, GEORGE WASHINGTON, M.E., '10. Box 304, Pensacola, Fla.
GRIMES, CHARLES EDMUND, M.E., '10. New Jersey Zinc Works. (2) and (3) Palmerton, Pa. (1) 263 Columbia Ave., Palmerton, Pa.
GRIMM, BRUCE FULTON, M.E., '14. Electrical Engineer. (1) and (3) 228 Kelley Pl., Fairmont, W. Va. (2) Consolidation Coal Co., 505 Watson Bldg., Fairmont, W. Va.
GRIMSHAW, FREDERICK GEORGE, M.E., '00. 5026 Friendship Ave., Pittsburg, Pa.
GRISWOLD, CHARLES EDWIN, '97. Address not known.
GROOS, RICHARD ARTHUR, M.E., '14. 84 32d St., Newport News, Va.
GROSS, CHARLES PHILIP, '10. 1079 Decatur St., Brooklyn, N. Y.
GROSS, LOUIS, M.E., '03. Care F. D. Woolworth Co., Bay City, Mich.
GROSS, PHILLIP WILLIAM, M.E., '14. 467 Wahl Ave., Milwaukee, Wis.
GROVE, ELMER EMANUEL, '09. Luray, Va.
GRUEN, EDW. CHAS., M.E., '12. Asst. Prof. Ga. School of Technology. (2) and (3) Ga. School of Tech., Atlanta, Ga. (1) 36 Broad St., Tonawanda, N. Y. A. I. E. E., Tau Beta Pi, Phi Kappa Phi.
GRUMBEIN, JOHN BEHNY, M.M.E., '14. Assoc. Prof. Power and Experimental Engr., W. Va. Univ. 195 Grant Ave., Morgantown, W. Va. A. S. P. E. E., A. S. T. M.
GRUMMAN, LEROY RANDLE, M.E., '16. Engineering Assistant. (1) and (3) Huntington, L. I., N. Y. (2) 195 Broadway, New York City. A. I. E. E., E. H. N.

GRUNER, WILLIAM PHILIP, M.E., '07. 4006 N. Broadway, St. Louis, Mo.
GUANES, LUIS ISAAC, M.E., '12. Ricoleta, Asuncion, Paraguay.
GUENTHER, ANDREW MITCHEL, M.E., '97. 189 Burr Oak Ave., Blue Island, Ill.
GUENTHER, VICTOR JOHN, M.E., '07. 19 Landen St., Buffalo, N. Y.
GUERRERO, JULIO, M.E., '96. Apartado 14, Durango, Mex.
GUERRERO, MANUEL, M.E., '95. 48 Mercado St., Durango, Mex.
GUILBERT, ROSCOE PEASE, '11. 107 11th St., Racine, Wis.
GUILDFORD, CHARLES THOMAS, M.E., '04. Workman Ave., Torrington, Conn.
GUILLEN, SALVADOR ANTONIO, M.E., '01. Granada, Nicaragua, C. A.
GULICK, RAYMOND W., '05. Water Supply Dept. Room 2449 Municipal Bdlg., New York City.
GURLEY, RICHARD HAMILTON, '09. 428 Pembroke Ave., Norfolk, Va.
GUYER, EDWARD RAWSON, M.E., '15. 728 21st St., Rock Island, Ill.
GUYER, HARRY WILLIAM, '96. Sunbury, Pa.

HAAG, WILLIAM, M.E., '11. (1) and (3) 738 Central Ave., Albany, N. Y. (2) Room 32 Union Sta., Albany, N. Y.
HAAS, MAGMIS SIGMUND, M.E., '02. Gen. Mgr. Empire Plow Co., Cleveland, Ohio. (1) 3164 E. 65 St., Cleveland, O. (2) and (3) 1060 Eg 8, Cleveland, Ohio.
HACKETT, CHARLES FREDERICK, M.E., '98. 98 Heimeway St., Boston, Mass.
HACKETT, HOLLAND BERKELEY, M.E., '06. 422 Drexel Bldg., Philadelphia, Pa.
HACKSTAFF, FREDERICK WILLIAM, M.E., '05. Am. Mfg. Co., Noble and West Sts., Brooklyn, N. Y.
HACKNEY, HERBERT, '77. 911 Monroe St., Topeka, Kan.
HACKNEY, ROSCOE JAMES, '08. Care Mark H. Brown Lbr. Co., Memphis, Tenn.
HADLEY, CLARENCE GEORGE, M.E., '07. 56 Morris St., Albany, N. Y.
HADLEY, GEORGE CLARENCE, '01. 63 Hall St., North Adams, Mass.
HADLEY, HOWARD DAVID, M.E., '11. Seneca Falls, N. Y.
HAFF, WARREN COLEMAN, M.E., '12. Islip, L. I., N. Y.
HAGAR, EDWARD MCKIM, '94, M.M.E. Pres. Univ. Portland Cement Co. Chicago, Ill.
HAGEMAN, HARRY ANDREW, M.E., '99. Stone & Webster. 55 Ballard St., Newton Centre, Mass.
HAGEN, ALBERT MONTGOMERY, M.E., '17. 408 Zara St., Pittsburg, Pa.
HAGER, EDWARD CHARLES, '95. Elec. Engineer. (2) Solvay Process Co., Syracuse, N. Y. (3) 522 Summit Ave., Syracuse, N. Y. A. S. M. E.
HAGERTY, JAMES ANDREW, '01. Publisher, Plattsburg, N. Y.
HAGGERT, ROBERT SINCLAIR, '86. Brampton, Canada.
HAGGETT, EARLE CLIFFORD, M.E., '92. (1) 432 Eagle St., Dunkirk, N. Y. (2) and (3) Am. Loco. Co. Brooks Wks., Dunkirk, N. Y.
HAHL, EDWARD AUGUSTUS, M.E., '09. Ball Engine Co. (2) Ball Engine Co., Erie, Pa. (3) 819 W. 7th St., Erie, Pa.
HAHN, VICTOR IGNATIUS, M.E., '90. Supt. W. P. & Y. R. Rail Division. (2) and (3) Skagway, Alaska.
HAIG, MAHAM HUME, M.E., '00. Care Motive Power, Santa Fe Ry., Topeka, Kan. 815 Topeka Ave., Topeka, Kan.
HAINES, CHARLES ALVIN, M.E., '08. Slatington, Pa.
HAINES, CHARLES FORMAN, '08. 921 E. State St., Ithaca, N. Y.
HAINES, EDWARD PRESTON, M.E., '96. Whereabouts unknown.
HAINES, ROBERT WADE, '06. Angelica, N. Y.
HAIST, FOSTER ADELBERT, M.E., '11. Fact. Supt. Keystone Mfg. Co. (2) and (3) 41 Chandler St., Buffalo, N. Y. (1) 35 Fillinghast Pl., Buffalo, N. Y.
HALE, ANDREW, M.E., '16. 48 Rhodes Ave., Akron, O.
HAIRE, ANDREW JOSEPH, JR., M.E., '05. 200 5th Ave., New York, N. Y.
HALE, HERBERT, JR., '09. Advertising. Old South Bldg., Boston, Mass.
HALE, ROBERT MARION, '96. Mining Supplies. Box 363, Butte, Mont.
HALE, ROBERT SEVER, '93. Edison Co. (1) 939 Boylston St., Boston, Mass. (2) and (3) 39 Boylston St., Boston, Mass. A. S. M. E., A. I. E. E.
HALE, RODGERS, '07. Towanda, Pa.
HALE, STEPHEN CUTLER, M.E., '12. Resident Engr. (1) and (2) International Paper Co., Bellows Falls, Vt. (3) 26 South St., Bellows Falls.
HALL, CHARLES FREDERICK, '93. 315 W. Church St., Elmira, N. Y.
HALL, CHARLES WARD, '95. Const. Engr. (1) 190 Nassau St., New York City. (1) and (3) Larchmont Manor, N. Y.
HALL, EDWIN ARTHUR, '04. Manufacturer. 32 Main St., Binghamton, N. Y.
HALL, FREDERICK PERRY, JR., M.E., '14. 211 Lake View Ave., Jamestown, N. Y.
HALL, JAMES DONALD, M.E., '10. Bus. Care Stone & Webster Engr. Corporation. 1405 Rusk Ave., Houston, Tex.
HALL, JOHN HERBERT, '96. Pres. and Treasurer Conduits Co. 126 Don Esplinade, Toronto, Can.
HALL, JOSEPH LINVILLE, '91. Care Spenser Kellogg & Sons. 244 Olive Bldg., Boston, Mass.
HALL, LORENSO THOMAS, '88. Wyanette, Ill.
HALL, LOUIS JOHNSON, '96. 254 Rose St., Freeport, L. I., N. Y.
HALL, SELDEN HAMLIN, M.E., '03. Experimental Engr. (2) Care De Saval Separator Co., Poughkeepsie, N. Y. (3) 87 S. Cherry St., Poughkeepsie, N. Y.
HALL, THOMAS, '93 M.E., '94 M.M.E., Supt. Ridgeway Dynamo & Eng. Co. Ridgway, Pa.
HALL, QUINCY ALLEN, '07. Milford, Ill.
HALLADAY, HARRY FRANK, '03. Depauville, N. Y.
HALLE, JEROME NORMAN, '07. Woodland and E. 9th St., Cleveland, O.
HALLE, SIMON, M.E., '14. Heating Den'ce Engineer. (2) and (3) G. E. Co., Pittsfield, Mass. (1) Lacke Court, Linden Ave., Baltimore, Md. A. I. E. E.
HALLEY, SAMUEL RUSSELL, '14 M.E. Bank Teller. Rapid City, S. D.
HALLORAN, HARRY RICHMOND, M.E., '06. Double Bay, Sidney, Australia.
HALLSTEAD, FRANK NATHANIEL, JR., M.E., '09. Garage Manager. (2) and (3) 409 Wyoming Ave., Scranton, Pa. (1) Clark's Summit, Pa.
HALSEY, FREDERICK ARTHUR, M.E., '78. 505 Pearl St., New York City. 356 W. 120 St., New York, N. Y.
HALSEY, PERCY FOSTER, M.E., '15. Newport News, Shipbuilding and Drydock Co. 221 33d St., Newport News, Va.
HALSTEAD, JOHN PRESTON, M.E., '08. Asst. Gen. Supt., Rome Brass and Copper Co., Rome, N. Y. (2) and (3) 506 N. Madison St., Rome, N. Y.
HALSTED, GILBERT CONSTANT, JR., M.E., '14. 308 Washington Ave., Brooklyn, N. Y.
HALSTED, HAROLD CAMERDEN, M.E., '14. 308 Washington Ave., Brooklyn, N. Y.
HAM, CLARENCE WALTER, M.E., '08. Asst. Prof. Machine Design. Sibley College, Cornell, Ithaca, N. Y. *For mail* 315 N. Geneva St., Ithaca, N. Y.
HAMANN, HENRY GEORGE, M.E., '92. Gen. Elec. Co., West Lynn, Mass.
HAMANT, MAX JOSEPH, M.E., '12. Mfg. Munitions. (1) and (3) 352 Norton St., New Haven, Conn. (2) Winchester Repeating Arms Co., New Haven, Conn.
HAMBLETON, ROSCOE LEE, M.E., '17. (1) School St., Orchard Park, N. Y. (2) and (3) Sperry Gyroscope Co., Brooklyn, N. Y.
HAMBLIN, LOUIS TUCKER, M.E., '15. Western Elec. Co. (2) and (3) Hawthorne, Ill. (1) 10 State St., Worcester, Mass. Tau Beta Pi.
HAMILTON, ALEXANDER MORTON, M.E., '09. American Locomotive Co., Petrograd, Russia.
HAMILTON, BRUCE HAYDON, '99. Westinghouse Elec. & Mfg. Co. Kibbe Bldg., Washington, D. C.
HAMILTON, FLOYD LINSLEY, '08. Knowlesville, N. Y.
HAMILTON, JAMES, M.E., '01. Patent Lawyer. 31 Nassau St., New York, N. Y.
HAMILTON, JOHN MCMILLAN, '94. Insurance, Care Samuels, Cornwall & Stevens, Inc. 84 William St., New York City.
HAMILTON, PAUL HOLLAND, Packard Elec. Lt. Co., St. Catherine, Canada.
HAMILTON, RALPH BERGEN, M.E., '96. Pres. and Gen. Mgr. (2) and (3) Packard Elec. Co., St. Catharines, Ont., Can. (1) 30 Bellevue Terrace, St. Catharines, Ont. A. S. M. E., A. I. E. E.
HAMLIN, EDWIN THOMPSON, '95. 556 Newbury St., Boston, Mass.
HAMLIN, GEORGE SCOVILLE, JR., '13. 192 Donaldson Ave., Rutherford, N. J.
HAMM, OTTO HENRY, M.E., '17. Roland Park, Baltimore, Md.
HAMMOND, EARNEST BENJAMIN, '01. 9 Waterbury St., Saratoga Springs, N. Y.
HAMMOND, FREEMONT MORTIMER, M.E., A.B., '17. 160 Main St., Patchogue, N. Y. Eta Kappa Nu.
HAMMOND, JOHN BEALL, '11. 620 Market St., Steubenville, O.
HAMMOND, LAURENS, M.E., '16. McCord Mfg. Co., Detroit, Mich.
HAMNER, CHARLES SUTHERLAND, M.E., '89. 115 Broadway, New York, N. Y.
HAMPTON, WILLIS HERBERT, M.E., '89. Canaseraga, N. Y.
HANAU, N. A., '16. 63 Broadway, New York City.
HAND, J. L., '11. Pelham, Ga.
HAND, MILES TRACY, M. E., '97. 541 6 St., Brooklyn, N. Y.
HANDY, ROBERT GOUDY, M.E., '10. Mgr. of Coal Mines. (1) 700 Midland St., Atlanta, Ga. (2) and (3) 700 Midland St., Bay City, Mich.
HANFORD, JOHN WILLIAM, M.E., '09. (1) 302 N. Main St., Butler, Pa. (2) and (3) 499 Delaware Ave., Albany, N. Y.
HANFORD, RAYMER TODD, M.E., '97. 412 Harmony Bldg., Sharon, Pa.
HANFORD, WILLIAM BROWN, M.E., '13. Care Seattle Car & Foundry Co., Seattle, Wash.
HANIGHEN, JOHN JOSEPH, JR., M.E., '17. 327 S. 37th St., Omaha, Neb.
HANKS, CLINTON THORNTON, '13. Hamilton Ave., Trenton, N. J.
HANNA, RICHARD WRIGHT, '13. Asst. Supt., Standard Oil Refinery, El Segunda, Cal.
HANNAM, GEORGE CLIFTON, M.E., '13. 121 6th Ave., Brooklyn, N. Y.
HANNOCK, CHARLES GUSTAVE, '02. Care Palmer Reality Co., 1109 Avenue C, Miami, Fla.
HAPGOOD, WILLIAM, '08. Niagara Falls, N. Y.
HARDI, CHARLES GUY, M.E., '02. 164 W. Huron St., Buffalo, N. Y.
HARDING, ADALBERT, M.E., '97. Hotel Beechwood, Summit, N. J. 50 Church St., New York, N. Y.
HARDINGE, H. T., M.E., '16. Care Hardinge Conical Mill Co. 120 Broadway, New York City.
HARDING, HAROLD C., M.E., '10. Gen. Foreman, Bessemer Dept. (1) and (3) 823 Ellicott St., Buffalo, N. Y. (2) Lackawanna Steel Co., Lackawanna, N. Y.
HARDY, CARL EARNEST, E.E., '00. Supt. of Elec. Dept. of City of Oakland, (2) and (3) City Hall, Oakland, Cal. (1) 3410 Richmond Ave., Oakland, Cal. A. I. E. E.
HARGREAVES, RICHARD LESTER, '98. 53 Romeno St., Detroit, Mich.
HARGREAVES, ROBERT C., '09. Traffic Engr., Federal Motor Truck Co. (2) Federal Motor Truck Co., Detroit, Mich. (1) and (3) 53 Leicester Court, Detroit, Mich. A. S. M. E.
HARKNESS, ANDREW MARR, M.E., '05. Care Abendroth & Root. Newburgh, N. Y.
HARPER, CHARLES WINFRED, M.E., '12. Chief Engr. and Mgr., Yancey Light & Power Co. Burnsville, N. C.
HARPER, JOHN LYELL, M.E., '97. Chief Engineer. (1) Lewiston, N. Y. (2) and (3) Hydr. Power & Mfg. Co., Niagara Falls, N. Y.
HARPER, THOMAS EDWIN, '13. New Brighton, N. Y.
HARRINGTON, ARTHUR MELVIN, M.E., '05. 821 Westview St., Germantown, Pa.
HARRINGTON, WELLESLEY CARL, M.E., '13. Care Highway Commission, Albany, N. Y.
HARRIS, ALBERT WILLIAM, '97. (1) Glens Falls, N. Y. (2) and (3) Grand Mere, P. I., Canada.
HARRIS, ELIOT HUNTINGTON, M.E., '15. 33 W. 93 St., New York City.
HARRIS, ERNEST NYE, M.E., '08. Montezuma, Iowa.
HARRIS, HERBERT GOODMAN, M.E., '10. Sales representative. Care Dietzgen Co., 218 E. 23d St., New York City. (2) 25 Austin Place, Bloomfield, N. J. (3) 10 West 84th St., New York City.
HARRIS, JESSE E., M.E., '04. Harrison Safety Boiler Wks., Philadelphia, Pa. (2) and (3) 3726 N. 19th St., Philadelphia, Pa. (1) 4603 Pulaski Ave., Philadelphia, Pa.
HARRIS, RICHARD GREEN, M.E., '07. Care Standard Underground Cable Co. New Binks Bldg., Montreal, Can.
HARRIS, SAMUEL THOMAS, M.E., '11. 127 Prospect St., Ashtabula, O.
HARRIS, WILLIAM A., M.E., '93. Manager. American Sheet & Tin Plate Co., Canton, Ohio. 1338 Cleveland Ave., Canton, Ohio. A. S. M. E. Amer. Iron and Steel Inst.
HARRIS, WILLIAM JOHN, JR., M.E., '05. Room 21, P. O. Bldg., Norfolk, Va.
HARRISON, FRANK, '94. Care Geo. B. Harrison, Pawling Ave., Troy, N.Y.
HARRISON, GWYNNE PAGE, '01. Millwood, Va.
HARRISON, HARRY, M.E., '07. (2) and (3) N. Y. Sales Mgr., Brunswick, Refrg. Co., Room 418, 30 Church St., New York, N. Y. (1) 598 W. 191st St., New York, N. Y. Jr. A. S. M. E.
HARRISON, ROSS RAY, M.E., '08. 50 Church St., New York, N. Y.
HARRISON, WILLIAM TAYLOR, M.E., '07. Mgr. John Wood Iron Works. (2) Box 2045. (1) and (3) 461 E. Alder St., Portland, Ore.
HARRON, HAL SARVEN, '96. 130 Victoria St., Eglinton, Ont., Canada.
HART, ALBERT EDWARD, '11. Care P. Hart & Sons. (2) and (3) New Brighton, Staten Island, N. Y. (1) Franklin Ave., New Brighton, Staten Island, N. Y.
HART, CARLOS DEMPSTER, M.E., '06. Western Elec. Co., Chicago, Ill.
HART, E., '16. 228 N. Chestnut St., Clarksburg, W. Va.
HART, JOHN THOMAS, '03. Address not known.
HART, R., M.E., '16. 494 Jamaica Ave., Brooklyn, N. Y.
HART, WILBUR DYRE, '10. Care I. N. U. Co., Dixon, Ill.
HARTFORD, CLAUDE, M.E., '10. The N. Y. Steam Co. (2) and (3) 90 West St., New York City. (1) 910 Caton Ave., Brooklyn, N. Y.
HARTIGAN, IRVING CRESS, M.E., '08. Box 1160, Manila, P. I.
HARTLEY, CARNEY, M.E., '94. Sales Engineer. 316 Colorado Bldg., Denver, Col.
HARTLEY, SEWARD WILSON, '01. (2) and (3) Gen. Mgr. Ladish Drop Forge Co., Cudahy, Wis. (1) 360 Prospect Ave., Milwaukee, Wis.
HARTMAN, JAMES DENNISON, M.E., '03. Hollidaysburg, Pa.
HARTNELL, STEPHEN ELIHU, '94. Address not known.
HARTNETT, EDWARD HAZARD, '06. 289 York St., Jersey City, N. J.
HARTNETT, MICHAEL ARNOLD, M.E., '07. 1035 Broadway, Beaumont, Tex.

HARTUNG, Marion John, M.E., '08. 650 E. 26 St., Paterson, N. J.
HARTWELL, George Vail, M.E., '09. Care Parkinson & Burr, 7 Wall St., New York City.
HARTWIG, Max Armin, M.E., '05. Estimator. (1) Y. M. C. A., Hamilton, O. (2) Mosler-Safe Co., Hamilton, O.
HARTZELI, Charles Routt, '13. San Juan, P. R.
HARTZELL, Donald W., M.E., '08. General Mgr. Northwest Trading Co. (2) and (3) 2101-4 L. C. Smith Bldg., Seattle, Wash. (1) 1632 17th Ave., Seattle, Wash.
HARVEY, Clarence Ford, M.E., '02. Harvey Sons Mfg. Co., Ltd., Detroit, Mich.
HARVEY, George Roy, M.E., '93. 40 Robinson St., Hamilton, Canada.
HARVEY, Julian, M.E., '16. Phila. Drying Machinery Co. (2) and (3) 6721 Germantown Ave., Philadelphia, Pa. (1) Hasbrouck Hts., N. Y.
HARWOOD, Sumpter Lea, '97. Uniontown, Ala.
HASBROUCK, Philip Bevier, M.E., '96. Supt. of Water Company. Yucaipa, San Bernadino Co., Cal.
HASELTON, Philip Hyatt, '15. Coshocton, O.
HASKELL, Clifton Roy, M.E., '08. 25 Belmont Ave., Jersey City, N. J.
HASKELL, Frank Edward, M.E., '06. Asst. Examiner U. S. Patent Office. (1) and (3) 438 Park Rd., Washington, D. C. (2) U. S. Patent Office, Washington, D. C. A. I. E. E., Nat. Elec. Light Ass., Society for the Promotion of Engineering Education.
HASKIN, Hiram Lowe, '80. Druggist, Ithaca, N. Y.
HASKIN, Laurence Sprogue, M.E., '02. Farmer. "Ualmar," Glenham, N. Y.
HASLETT, Henry Ernest, '06. Farmer. Seneca, N. Y.
HASSELFELDT, Ernest Charles, M.E., '97. Designer Hanna Engineering Wks., Chicago, Ill. 6006 Champlain Ave., Chicago, Ill.
HASTINGS, Arthur Chapin, jr., M.E., '10. Care Ladd Lime Co. 3 Nat. Bank Bldg., Atlanta, Ga.
HASTINGS, Harold Edward, M.E., '01. Electrical Contractor. (2) Opp. Post Office, Yankton, S. D. (1) and (3) 411 Locust St., Yankton, S. D.
HASTINGS, Orlando Burr, M.E., '10. Supt. A. M. Writing Paper Co. (2) and (3) Niagara Falls, N. Y. (1) 243 Linden St., Niagara Falls, N. Y.
HATCH, A. E., '16. 304 Argyle Rd., Brooklyn, N. Y.
HATCH, Alvin Stem, M.E., '17. 2336 Grandview Ave., Cleveland Hts., Cleveland, O.
HATCH, Charles Collins, '07. 532 South Van Ness Ave., Los Angeles, Cal.
HATCH, Williard Treat, '74. Address not known.
HATHAWAY, Augustus Jeremiah, jr., '10. 135 Regent St., Welland, Ontario, Canada.
HATFIELD, Albert Richard, ME., '97. 839 Genesee St., Utica, N. Y.
HATFIELD, William De Wolfe, '15. Storrs, Conn.
HAUGH, Benjamin Franklin, '15. 420 W. 12 St., Anderson, Ind.
HAUG, Frederick William, M.E., '08. 225 E. 51 St., New York, N. Y.
HAVILAND, J. R., '16. 183 College Ave., West New Brighton, N. Y.
HAWKINS, Elbert Allen, M.E., '99. Western Elec., New York City.
HAWKINS, Harold Smith, '11. 2056 E. 77 St., Cleveland, O.
HAWKINS, Wilford Judson, '02. First Lieut., Ordnance Dept., U. S. Army, Springfield Armory, Springfield, Mass.
HAWLEY, Charles Gilbert, '90. Patent Lawyer, 630 Marquette Bldg., Chicago, Ill.
HAWLEY, Douglass C., M.E., '16. 115 S. 4th St., Minneapolis, Minn.
HAWLEY, Everett Malcolm, '05. 309 Highland Ave., Chestnut Hill, Philadelphia, Pa.
HAWLEY, William Guy, M.E., '97. Address not known.
HAWORTH, Charles Verne, '07. 45 Commercial St., Adams, Mass.
HAXTUN, Kenneth Goadby, '10. Production Clerk. (1) and (3) 125 W. Kennedy St., Syracuse, N. Y. (2) Brown-Lipe-Chapin Co., Syracuse, N. Y.
HAY, Edward Northrup, M.E., '12. 40 High St., Springfield, Mass.
HAY, Francis Wilkinson, M.E., '15. 162 Clinton Ave., Newark, N. J.
HAYNES, Frederick Jacob, '95. 76 Forrest Ave., East, Detroit, Mich.
HAYNES, Edward, M.E., '15. 54 Remsen St., Brooklyn, N. Y.
HAYN, Frederick Henry, M.E., '97. 1st Asst. Examiner. Patent Office, Washington, D. C.
HAYES, Alexander Tillison, M.E., '14. (1) 130 Engle St., Englewood, N. J. (2) and (3) Care Parkinson & Burr, 37 Wall St., New York City.
HAYES, Leslie David, M.E., '08. Asst. Professor of Machine Design. (2) and (3) R. 303 E. Sibley, Cornell, Ithaca, N. Y. (1) 23 E. Ave., Ithaca, N. Y.
HAYES, Rud Bryant, M.E., '02. 536 Thurston Ave., Ithaca, N. Y.
HAYES, Stanley Wolcott, M.E., '91. Pres. of Hayes Track Appliance Co. (2) Richmond, Ind. (3) and (1) 120 N. Third St., Richmond, Ind. A. S. C. E., Am. Geog. Soc., National Bank Director.
HAYDEN, John Harold, '02. Address not known.
HAYDEN, Edwin Clapp, '99. Engr. and Contractor, 16 City Square, Charlestown, Mass.
HAYASHI, Kiyonori, M.E., '04. Kanayawa, Japan.
HAYDOCK, John, 3d, M.E., '17. 464 Riverside Drive, New York City. Tau Beta Pi.
HAYNSWORTH, Harllee Saunders, '13. Darlington, S. C.
HAYS, Donald Symington, M.E., '06. 908 Illum Bldg., Cleveland, O.
HAYS, Louis Henry, '98. 2038 E. 82d St., Cleveland, Ohio.
HAYWARD, Ralph Baker, M.E., '99. La Grange, Ill.
HAZARD, Floyd Hamilton, M.E., '96. Catskill, N. Y.
HAZELTINE, Robert Henry, M.E., '99. (3) and (1) 251 West 88th St., New York City. (2) 17 W. 84th St., New York City.
HAZEN, Leslie Eugene, M.E., '16. Instr. Dept. Rural Engr., N. Y. S. College Agr., R. F. D. 2, Ithaca, N. Y.
HAZLETT, Henry Clark, '02. Stock Bond Broker. (1) Pleasant Valley, Wheeling, W. Va. (2) and (3) 215, 221 and 222 Schonalbach Bldg., Wheeling, W. Va.
HAZLEWOOD, Stuart, M.E., '03. Pacific Coast Mgr. Midvale Steel Co. (2) and (3) Monadnack Bldg., San Francisco, Cal. (1) 1131 Lake St., San Francisco, Cal. Phi Delta Theta, Amer. Inst. Mining Engrs.
HAZZARD, William Stuart, M.E., '16. 63 Peachtree Pl., Atlanta, Ga. A. S. M. E., A. I. E. E.
HEALY, Louis Watres, M.E., '90. 1503 Adams Ave., Scranton, Pa.
HEALEY, Raymond John, '94. Wabash Ave. and Adams St., Chicago, Ill.
HEALEY, Sumner Mansfield, '95. Care Warren Mansfield Healy, 1654 Broadway, New York City.
HEARIN, William Jefferson, '04. Lumberman. 923 Government St., Mobile, Ala.
HEARNE, Wm. Lowder, '02. Kansas City, Mo.
HEATH, Harry Edward, '88. 71 Church St., Hartford, Conn.
HEATH, Raymond Pierce, M.E., '11. 901 Hipple Bldg., Des Moines, Ia.
HECHHEIMER, Herbert, M.E., '06. Actic Ice Machine Co. (1) 343 E. 46 St., Chicago, Ill. (2) and (3) 602 Monadnock Bldg., Chicago, Ill.
HECHT, Eugene I., M.E., '11. (1) 423 W. Main St., Lock Haven, Pa. (2) and (3) Milton, Pa.
HEERMANS, Forbes, B.M.E., '78. Journalist. 217 Highland Ave., Syracuse, N. Y.
HEERMANS, Thaddeus Willison, '82. 1216 Judson Ave., Evanston, Ill.
HEERMAN, Thomas Minton, M.E., '10. Sales Engr., Allis Chalmers Mfg. Co. (2) West Allis, Wis. (1) 1216 Judson Ave., Evanston, Ill. (3) 5031 National Ave., West Allis, Wis.
HEFLINGER, Chester Lee, '13. Kansas City, Mo.
HEFTER, Leonard, '07. 13 Bennett St., Hornell, N. Y.
HEG, Ernest Clarke, M.E., '10. (1) 57 Union St., Montclair, N. J. (2) and (3) 31 W. 31 St., New York, N. Y.
HEGEWALD, Arthur Frederick, '87. Supt. and Mgr. 1002 E. Elm St., New Albany, Ind.
HEGEWALD, Edwin Christian, '93. 352 E. Spring St., New Albany, Ind.
HEGGEM, Alfred George, M.E., '97. 512 Daniel Bldg., Tulsa, Okla.
HEIDT, Alexander, M.E., 11. Carl Bldg., Pittsburg, Pa.
HEIKES, Chauncey Irving, M.E., '12. Royal Oaks, Talbot Co., Md.
HEINE, Henry Anton, M.E., '07. 6227 Georgia Ave., Washington, D. C.
HEISLER, Charles Louis, M.E., '90. (1) 325 Glenwood Blvd., Schenectady, N. Y. (2) and (3) American Locomotive Co., Schenectady, N. Y.
HEISLEY, Frederick Wm., M.E., '14. (1) 114 Biddle Ave., Wilkinsburg, Pa. (2) and (3) Care S. E. Heisley, 241 3d Ave., Pittsburgh, Pa.
HEIST, Lee Harrar, M.E., '05. Treas. and Gen. Mgr. Blaisdell. (1) 113 E. Durham St., Mt. Airy, Philadelphia, Pa. (2) and (3) Paper Pencil Co., Philadelphia, Pa.
HEITKAMP, Frederick Wm., M.E., '97. (1) Doremus Ave., Ridgewood, N. J. (2) and (3) Care N. Y. Telephone Co., 15 Dey St., New York, N. Y.
HEITMAN, Edward, jr., M.E., '95. Crocker-Wheeler Co., St. Catherine, Ont., Canada.
HEITSHU, Wm. A., M.E., '03. Asst. Mgr. of Wickersham Ry. Co. (2) 111-117 E. Chestnut St. (1) 30 North Lime St. (3) Box 550, Lancaster, Pa.
HEIZMANN, Lewis Joseph, M.E., '05. (1) 318 N. 5 St., Reading, Pa. (2) and (3) Penn. Hdw. Co., Reading, Pa.
HELFRICH, Henry Jacob, M.E., '13. (1) 438 Northampton St., Buffalo, N. Y. (2) and (3) Care Pierce-Arrow Motor Car Co., Buffalo, N. Y.
HEMINGWAY, Heighey Stewart, M.E., '09. Address not known.
HELLER, Harley Howard, M.E., '03. (1) 505 W. 187th St., New York City. (2) and (3) 104 John St., New York, N. Y.
HEMBERGER, John Fred, M.E., '09. 231 Lafayette St., Dayton, O.
HEMINGWAY, John Carlisle, M.E., '06. Glens Falls, N. Y.
HENDEE, Robert William, M.E., '17. Tulsa, Okla.
HENDERER, Willard Everett, '05. 800 Harrison St., Wilmington, Del.
HENDERSON, Eliot Middleton, '88. Rubber Manufacturer. 18 Vesey St., New York City.
HENDERSON, Henry Banks, M.E., '94, M.M.E., '95. Colonial Annex Hotel, San Francisco, Cal.
HENDERSON, John, M.E., '72. Care H. C. Henderson, White Plains, N. Y.
HENDERSON, Laurence Ambrose, '11. Equipment Supervisor. (1) and (3) 1339 Ardmore Ave., Chicago, Ill. (2) Care Western Union Telegraph Co., 327 South La Salle St., Chicago, Ill.
HENDERSON, Robt. Moss, jr., M.E., '09. 500 S. Court St., Montgomery, Ala.
HENDRICKS, James Franklin, M.E., '15. 411 W. Houston St., Sherman, Texas.
HENDRICKSON, Everett House, M.E., '06. 1431 Sterling Pl., Brooklyn, N. Y.
HENDRICKSON, George Smith, M.E., '11. (1) 11 Springfield Ave., Queens, L. I., N. Y. (2) and (3) 12 St. and Gowanns Canal, Brooklyn, N. Y.
HENDRY, William Ferris, M.E., '95. Electrical Engineer. 60 W. 10th St., New York City.
HENDRYX, George, M.E., '15. 602 W. Main St., Lead, S. D.
HENION, Hudson Dodge, '09. 17 Elmwood Ave., Geneva, N. Y.
HENKLE, Charles Zane, '15. 911 Church St., Evanston, Ill.
HENN, Edwin Charles, M.E., '15. Care Warner & Swassey Co., Cleveland, O.
HENNEY, David Simons, '11. 88 Lorraine Ave., Upper Montclair, N. J.
HENROTIN, Charles Martin, M.E., '97. 754 Lincoln Parkway, Chicago, Ill.
HENRY, Arthur Robert, M.E., '93. Mech. and Elec. Engineer. 633 Coristine Bldg., Montreal, Can.
HENSEN, Emil, M.E., '96. 1106 Park St., McKeesport, Pa.
HENTZ, Robert Alexander, M.E., '11. Station Construction Dept. (1) and (3) 6043 Carpenter St., Philadelphia, Pa. (2) The Philadelphia Elec. Co., 1000 Chestnut St., Philadelphia, Pa. N. E. L. A., A. I. E. E., Engineers Club of Philadelphia.
HEPBURN, Harry Louis, M.E., '97. 185 Belleville Ave., Bloomfield, N. J.
HEPBURN, Wm. McMeenM.E., '11. 15 Monument St., Freehold, N. J.
HEQUEMBOURG, J. T., '16. 873 St. Nicholas Ave., New York City.
HERBERT, Comly Mode, M.E., '97. Salesman and Engineer, W. E. V. M. Co. (2) Union Bank Bldg., Pittsburgh, Pa. (1) and (3) 421 Ross Ave., Wilkinsburgh, Pa. Railway Club of Pittsburgh.
HERBERT, Frederick Davis, M.E., '97. 90 West St., New York, N. Y.
HERBOLD, Carl J., M.E., '10. Arch. Engr. (2) and (3) Care Walker Weeks, 1900 Euclid Ave. (1) 13903 Castalia Ave., Cleveland, O.
HERDMAN, William James, M.E., '06. Chief Engr. and Patent Atty. Gen. Engr. and Const. Co. (2) and (3) 263 Adelaide St., W. Toronto, Can. (1) Jerseyville, Ill.
HERMES, Benjamin Post, '05. 21 Union Ave., Mt. Vernon, N. Y.
HERPEL, Chas. Wm., '04. Bookseller and Stationer, 416 8th St., San Antonio, Tex.
HERPEL, Harry Conrad, M.E., '06. Hersey Iron, Tube & Lead Co., Welland, Ont., Can. (1) 75 Fitch St., (3) P. O. Box 822.
HERR, Benj. Musser, M.E., '06. Westinghouse Mach. Co., E. Pittsburg, Pa.
HERRICK, John James, M.E., '91. 242 Amity St., Flushing, L. I., N. Y.
HERRICK, Paul Bernard, '96. Sales Mgr., Hardware Dept., Oneida Community Ltd., Oneida, N. Y. (1) (2) (3) Oneida, N. Y.
HEWITT, Carl T., M.E., '08. Asst. Research Eng., Steel Testing, Rem. Arm, (2) U. M. C. Co., Bridgeport, Conn. (1) and (3) 939 Barnum Ave., Bridgeport, Conn.
HERRIMAN, Victor Doraval, M.E., '08. 169 Quincy St., Brooklyn, N.Y.
HERRING, James Simms, '80. 1320 Chester St., Little Rock, Ark.
HERRING, Oscar Eugene, '02. Cismont, Va.
HERRINGTON, Samuel Edgar, '10. College Station, Tex. Agr. and Mech. College of Texas.
HERRMANN, Lionel Ellsworth, '13. Care Herrmann & Grace Co., 671, 689 Bergen St., Brooklyn, N. Y.
HERSCHEL, Arthur Hobart, M.E., '90. Riggs Natl. Bank, Washington, D. C.
HERSEY, George Dana, '75. Stetson, Me.
HERSEY, Theodore, '88. Montreal, Can.
HERZER, Edward Henry, M.E., '16. C. & P. Tel. Co., Baltimore, Md. (2) and (3) 108 E. Lexington St., Baltimore, Md. (1) 2829 N. Calvert St., Baltimore, Md. Tau Beta Pi, Eta Kappa Nu, A. I. E. E.
HESS, Alexander McDonald, M.E., '12. 380 Pine St., Brooklyn, N. Y.
HESS, Howard Arthur, '02. 12125 Harvard Ave., Chicago, Ill.
HESS, John Edward, M.E., '00. 23 E. Orange St., Lancaster, Pa.
HESS, Seymour Isaac, M.E., '14. Y. M. C. A., Newport News, Va.
HETZEL, Guy, M.E., '00. Martinsburg, W. Va.
HEUN, Sik Dong, '04. Seoul, Korea.

HEWITT, Charles Elbert, M.M.E., '95. Durham, N. H. A. I. E. E. Sec.

HEWITT, Carl T., M.E., '08. Engr. Equipment Division. (1) and (3) 403 Ridgefield Ave., Bridgeport, Conn. (2) 939 Barnum Ave., Rem. Arms U. M. C. Co., Bridgeport, Conn. A. S. M. E.

HEWITT, George Frederick, jr., M.E., '10. (1) 137 N. Mountain Ave., Montclair, N. J. 48 Beekman St., New York City.

HEWITT, John Marshall, M.E., '06. Marianna, Ark.

HEYWOOD, Francis C., M.E., '11. Supt. Paper Mill. (2) and (3) Whitman Mfg. Co., Holyoke, Mass. (1) 113 Pleasant St., Holyoke, Mass.

HIBBARD, Frank H., M.E., '14. Weston Elec. Co., New York, N. Y. (2) and (3) 204 W. 109 St., New York City.

HIBBARD, Harry Lyman, M.E., '99. Marine and Governmental Dept. Cutler Hammer Co., New York, N. Y. (3) and (2) 50 Church St., New York City. (1) 243 Stiler St., Elizabeth, N. J. Naval Architect and Marine Eng., A. I. E. E.

HIBBARD, H. Wade, M.E., '91. Prof. Mech. Engrg., University of Missouri. (1) (2) (3) 1307 Kaiser Ave., Columbia, Mo. A. S. M. E., Soc. Prom. Eng'g Ed., Sigma Xi.

HIBBARD, Leonard James, '04. 405 World Bldg., New York City.

HIBBERT, William John, '97. Sand Beach, Yarmouth, N. S., Canada.

HICKEY, John, '94. Address unknown.

HICKMAN, Spencer Eastman, M.E., '05. Owner Garage & Auto Repair Shop. (2) and (3) 145 King St., Northampton, Mass. (1) 135 Crescent St., Northampton, Mass.

HICKMAN, Willis Gregory, '11. Lawyer. (1) 1268 Main St., Buffalo, N. Y. (2) and (3) 9 German Insur. Co.'s Bldg.

HICKOK, Julian Peer, '11. Teacher. Chestnut Hill Academy, Germantown, Philadelphia, Pa. 120 E. Washington Lane, Germantown, Philadelphia, Pa.

HICKS, George Cleveland, jr., M.E., '90. P. H. & F. M. Roots Co., Connersville, Ind.

HICKS, William Edgar, '06. Cedarhurst, L. I., N. Y.

HICKS, William Gorgus, '10. 171 Washington St., Mt. Vernon, N. Y.

HICKSTEIN, William Lux, '07. 47 Steele St., Auburn, N. Y.

HIDER, George Turner, M.E., '09. Lake Prov. Cotton Oil Co., Lake Providence, La.

HIETT, Ralph Waldo, '08. 1412 Crenshaw Boul., Los Angeles, Cal.

HIGGINS, George Hendrick, '09. (2) and (3) 61 Lincoln Ave., Cortland, N. Y.

HIGGINS, Max Smith, '06. 1031 La Clair St., Swissvale, Pa.

HIGGINS, Ralph Holbrook, '10. 67 Brooks Ave., Newtonville, Mass.

HIGGINS, Wilson Freeman, M.E., '90. 119 Myrtle St., Manchester, N. H.

HIGHLAND, Caswell, M.E., '09. 366 First St., Niagara Falls, N. Y.

HIGLEY, Seth Duane, '94. Secretary. (1) 37 Marlborough Rd., Brooklyn. (2) and (3) Care Thomson Meter Co., 100 Bridge St., Brooklyn.

HILBORN, Herbert Hedley, M.E., '96. 511 Argyle Rd., Brooklyn, N. Y.

HILDEBRANT, Bertram Augustus, M.E., '06. Western Elec., New York, N. Y.

HILDRETH, Kenneth Evans, '12. (1) 8 S. 4th St., Hudson, N. Y. (2) and (3) Engr., N. Y. & N. E. C. & L. Co., Hudson, N. Y.

HILL, Benjamin Mason, M.E., '07. Elec. Contr. (2) and (3) 9 W. Sycamore St., Petersburg, Va. (1) Walnut Hill, Petersburg, Pa.

HILL, Ebenezer, M.E., '99. Gen. Mgr. and Treas. (2) S. Norwalk, Conn. (2) and (3) Norwalk Iron Wks., S. Norwalk, Conn.

HILL, Edward Albert, M.E., '15. (2) and (3) Care Fayette R. Plumb Co., Philadelphia, Pa. (1) 4623 Penn. St., Philadelphia, Pa.

HILL, Ernest Rowland, M.E., '93. Penn. Station, New York, N. Y.

HILL, John Henry, E.E., '97. Unknown address.

HILL, Harold Herbert, M.E., '97. 820 Citizens Bldg., Cleveland, O.

HILL, James DeWitt, jr., '06. Test Dept., F. B. Stearns Co., Cleveland, O.

HILL, John Whipple, B.M.E., '73. Gen. Timekeeper, Armour & Co. (2) and (3) Care Armour Co., Stock Yards, Chicago, Ill. 4943 Forestville Ave., Chicago, Ill.

HILL, Lockwood, M.E., '09. (1) 5542 Waterman Ave., St. Louis, Mo. (2) and (3) Gen. Elec. Co., Pierce Bldg., St. Louis, Mo.

HILL, Whiteside, 2d, '06. Greenwich, N. Y.

HILLS, Burton Arthur, '01. 33 Montgomery St., Hamilton, N. Y.

HILLEARY, John Francis, M.E., '98. Address not known.

HILLMAN, Sidney Maurice, '07. Address not known.

HILLYER, George, jr., E.E., '96. Mech. Engr., Valuation Dept. Southern R. R. (3) and (2) 1300 Penn. Ave., Washington, D. C. (1) 568 W. Peach Tree St., Atlanta, Ga. A. S. M. E., C. & C.

HILTEBRANT, Arthur, '15. Care Cramp Shipbuilding Co., Philadelphia, Pa. (1) and (3) 1421 Arch St., Philadelphia.

HILMER, Otto Ernst, M.E., '07. Eng. with W. S. Franz, Consulting Eng. Union Trust Bldg., Cincinnati, O. (1) and (3) 3121 Murdock Ave., Cincinnati, O. A. S. M. E.

HILTEBRANT, Oscar Raymond, M.E., '08. Presidents Pl., Rondout, N. Y.

HINCKLEY, John Fay, '03. Address unknown.

HINDE, John Kelly, '90. Columbus, Georgia.

HINDS, Elliot Prindle, M.E., '96. 927 Michigan Ave., Niagara Falls, N. Y.

HINMAN, Russel, jr., '13. 111 Broadway, New York City.

HINTON, Hammond Herbert, '07. Lumberton, Miss.

HIPPELY, Edward, '88. Address unknown.

HIRSHFIELD, Clarence Floyd, M.M.E., '06. 17th Floor, David Whitney Bldg., Detroit, Mich.

HIRSHHEIMER, Louis Carver, '03. Supt. and Sec., LaCrosse Plow Co., LaCrosse, Wis.

HITCHCOCK, Alfred Owen, jr., '01. 30 Pritchard St., Fitchburg, Mass.

HITCHCOCK, Embury A., M.E., '90. Engineer. (1) 348 West 8th Ave., Columbus, O. (2) and (3) E. W. Clark Management Corp., 10th Floor Huntington Bank Bldg., Columbus, O. A. S. M. E., A. S. N. E.

HITCHCOCK, Joseph F., M.E., '07. Experimental and Model Development. (1) (2) (3) 127 West Ave., Rochester, N. Y.

HITT, Samuel Edw., M.E., '91. Mechanical Draftsman, Natl. Tube Co., S. Lorain, Ohio. 426 W. 3d St., Elyria, O. Lorain County Engineers Club.

HOAGLAND, Frederick Baker, '05. Suffern, N. Y.

HOBART, Earle Tisdale, M.E., '08. Standard Oil Co. of N. Y. Newchang, Man., China.

HOBART, Lowell Fletcher, jr., '13. Sec. and Treas. James Kidney Co. (2) and (3) 2d & Lowell Sts., Cincinnati, O. (1) Garfield & Wallace Ave. Milford, Ohio.

HOBBY, Amos Knapp, '13. 105 Maple St., Richmond Hill, N. Y.

HOBERT, Stephen Galusha, M.E., '96. Consulting Engineer. (1) (2) (3) 4455 Woodlawn Ave., Chicago, Ill.

HOCKER, Merwyn J., M.E., '08. Highspire, Pa.

HODENPYL, George Henry, jr., '11. 123 Hobart Ave., Summit, N. J.

HODGE, Seth Evans, M.E., '03. Westinghouse E. & M. Co., Juneau, Alaska.

HODGE, Thomas Ditto, '08. Ne No Yan Club, Morgan Pk., Duluth, Minn.

HODGE, William Washington, M.E., '05. 140 June St., Worcester, Mass.

HODGES, Charles Rembert, jr., M.E., '14. Care Thompson & Sproull, 341 Fourth Ave., Pittsburgh, Pa. Care Wallace M. Reid & Co., Commonwealth Bldg., Pittsburgh, Pa.

HODGSON, Walter Blanchard, '07. (1) 1001 Prince Ave., Athens, Ga. (2) and (3) Hodgson Oil Refining Co., Athens, Ga.

HODGKINS, Henry Follett, M.E., '15. (1) 610 W. Onondago, Syracuse, N. Y. (2) and (3) Rem. Arms Co., 39 Jane St., Bridgeport, Conn.

HOERA, Carl Lewis, '14. (1) 307 Blaine St., Canton, Ohio. (2) and (3) Hoera-Rosenthal Safe Co., Fort Worth, Texas.

HOFFMAN, Albert Baldwin, '05. Bond Salesman. (2) and (3) Keneth Corvan & Co., 615 Ford Bldg., Detroit, Mich. (1) 126 McDougall Ave., Detroit, Mich.

HOFFMAN, Frederick Louis, M.E., '09. Lyons, N. Y.

HOFFMAN, Sargent Glenn, '10. Ranching. (1) (2) (3) Geyserville, Sonoma Co., Cal.

HOFFMAN, Schuyler V., jr., '13. (1) 60 E. Penn. St., Germantown, Pa. (2) and (3) Care Natl. Tube Co., Pittsburgh, Pa.

HOFFMAN, Wray Bowman, '15. 603 Hoffman St., Elmira, N. Y.

HOFFMAN, William Levi, M.E., '98. Univ. Club, Tacoma, Wash.

HOFFMANN, Bernhard, M.E., '95. Consulting Engr. (2) and (3) 103 Park Ave., New York City. Stockbridge, Mass. A. I. E. E.

HOFFMANN, Charles Barth, M.E., '11. (1) 2619 Vine St., Cincinnati, O. (2) and (3) 2312 Rohs St., Cincinnati, O.

HOFFMIRE, J. S., M.E., '16. R. F. D. 31, Trumansburg, N. Y.

HOGAN, John Joseph, '02. 159 Summer St., Fitchburg, Mass.

HOGAN, John Rippon, '11. 64 Prospect Ave., Montclair, N. J.

HOGAN, William Edward, '06. (1) 215 Salem St., Bridgeport, Conn. (2) and (3) Asst. Order Supt. Remington Bridgeport Works of the Remington Arms-Union M. C. Co., Bridgeport, Conn.

HOGE, Joseph Franklin Dix, M.E., '06. (1) 509 W. 121st. St., New York City. (2) and (3) The Maintenance Co., 417 Canal St., New York City. Chief Engineer. A. I. E. E., A. E. S.

HOGG, Coy Claude, M.E., '14. (1) and (3) 307 E. Central Ave., Titusville, Pa.

HOGLE, William Manville, '06. 311 Main St., Decorah, Iowa.

HOHNER, Edwin, M.E., '06. Joseph T. Ryerson & Son, Chicago, Ill. 14 Eastwood Ave., Buffalo, N. Y.

HOLBROOK, Dio Lewis, M.E., '92. 46 E. 21 St., New York, N. Y.

HOLBROOK, John Byers, M.E., '96. Vanderbilt Concourse, New York City. 303 W. 80 St., New York, N. Y.

HOLCOMBE, Donald Bellis, '12. (2) and (3) Letter Carrier, Post Office, Asbury Park, N. J. (1) 512 Asbury Ave., Asbury Park, N. J.

HOLCOMBE, Ernest Selah, M.E., '10. 201 DeWitt Ave., Ithaca, N. Y.

HOLDEN, Charles Bierce, M.E., '01. 378 Irving Pl., Milwaukee, Wis.

HOLDEN, Edgar Buckingham, jr., M.E., '94. Gen. Elec. Co., Schenectady, N. Y.

HOLDEN, Richard Orlando, M.E., '11. 729 Warren St., Hudson, N. Y.

HOLDEN, Sanford Scribner, '05. 651-653 R. R. Exchange Bldg., Chicago, Ill. Kenilworth, Ill.

HOLLANDS, Stephen Charles, '08. Merchant. (1) 16 Willow Place, Hornell, N. Y. (2) and (3) 76 Main St., Hornell, N. Y.

HOLLENBECK, Brua Arnot, '08. (1) 119 Walnut St., Bloomfield, N. J. (2) and (3) Western Elec. Co., New York, N. Y.

HOLLENBECK, Harry Bell, M., '06. Address unknown.

HOLLENBERGER, Theodore James, M.E., '09. Heating and Ventilating Draftsman., Bd. of Education, Architects Office, 910 Ainslie St., Chicago, Ill. 4433 N. Paulina St., Chicago, Ill. A. S. M. E.

HOLLIDAY, John Salisbury, '06. 1202 Franklin Ave., Wilkinsburg, Pa.

HOLLOWAY, Carl Sheldon, '94. 39 Merchant St., Honolulu, Hawaii.

HOLLOWAY, Harold Euclid, M.E., '00. Unknown address.

HOLMAN, William Baker, '04. 326 Victoria Bldg., St. Louis, Mo.

HOLMAN, Webster Palmer, M.E., '05. 2208 Bellaire St., Denver, Col.

HOLMES, Andrew Allgood, '04. Box 1042, Atlanta, Ga. 1209 Stephen Girard Bldg., Philadelphia, Pa.

HOLMES, Howard Abbott, M.E., '06. (1) and (3) 1108 N. Rens. St., Pensacola, Fla. (2) U. S. Navy Aeronautic Station. A. I. E. E.

HOLMES, Webster Balkwill, M.E., '07. 802 Story Bldg., Los Angeles, Cal.

HOLT, John Washburn, '08. The Standard Welding Co. (2) and (3) 1208 Kenilworth Ave., S. W., Cleveland, O.

HOLTZ, Alexander Christian, '15. 253 29th St., Milwaukee, Wis.

HOLWAY, Charles Hogan, '00. 429 State St., La Crosse, Wis.

HOLZ, Fred Herbert, '02. 415 Ludlow Ave., Cincinnati, O.

HOLZHEIMER, Gerald Lee, '08. 5310 Woodlawn Ave., Chicago, Ill.

HOMER, Edward Clark, M.E., '17. 244 Forest Ave., River Forest, Ill.

HOOK, Warren Howard, '08. Instructor, Cornell. 208 Hook Pl., Ithaca, N. Y.

HOOPER, Franklyn Dana, M.E., '07. 430 Sterling Pl., Brooklyn, N. Y.

HOOPER, Parr, '13. N. Y. Shipbuilding Co., Camden, N. J. 219 9th Ave., Haddon Hts., N. J.

HOOPES, Maurice, '01. Pres. Finch Pruyn & Co., Glens Falls, N. Y.

HOPE, Bertram Cedric, '13. (2) and (3) Champion Fibre Co., Canton, N. C. (1) Dudley St., Randwick, New South Wales.

HOPE, Clarkson Campbell, M.E., '13. Semet Solvay Co., Detroit, Mich. Roselle, N. J.

HOPKINS, Ralph E., M.E., '12. West Bloomfield, N. Y.

HOPPIN, Frederick Layton, M.E., '07. Box 63, R. F. D. 2, Medford, Ore.

HOPPIN, John Keene, '06. Salesman, Steel, Coal, Iron, etc. (2) and (3) 834 Security Bank Bldg., Minneapolis, Minn. (1) 3029 Humbolt Ave. S., Minneapolis, Minn.

HOMAN, Alfred Glenn, '15. 126 Linden Ave., Ithaca, N. Y.

HORNICKEL, Frank Lute, '15. 11418 Bellflower St., Cleveland, O.

HORNE, C. Francis, '97. Mgr., N. Y. Office, Sterling Blower Co. (2) and (3) 39 Cortlandt St., New York City. (1) 145 Lefferts Place, Brooklyn, N. Y.

HORTON, Erwin Churchill, '10. Hamburg, N. Y.

HORTON, Earl Thomas, '11. Ulster, Pa.

HORTON, Stephen Sutton, '14. Yorktown Heights, N. Y. (1) Mt. Kisco, N. Y.

HOSCHKE, William Edward, M.E., '08. 455 Ocean Ave., Brooklyn, N. Y.

HOSHINO, Junkich, '05. 79 Matsushima St., Osaka, Japan.

HOTCHKISS, Howard Clare, '15. R. F. D. 2, Marietta, N. Y.

HOTCHKISS, Homer James, M.M.E., '96. Prof. of Physics. 5044 Cedar Ave., Philadelphia, Pa.

HOU, Ching Fei, '13. Kalgan Workshop, Peking-Kalgan Ry., Kalgan, China.

HOUCK, Harvey Francis, M.E., '17. 317 W. 1st St., Elmira, N. Y. A. I. E. E., A. S. M. E.

HOUGH, Benj. Kent, M.E., '97. (2) Mgr. Boston Office, Richardson Scale Co. (3) 201 Devonshire St., Boston, Mass. (1) 158 Salisbury Rd., Brookline, Mass.

HOUGH, Chester Carroll, M.E., '17. Clarendon, Va. Eta Kappa Nu.

HOUGHTON, Bert H., '92. Constr. Engr. and Asst. Engr. Operating Dept. (1) and (3) 673 E. 21 St., Brooklyn, N. Y. (2) 360 Pearl St., Brooklyn, N. Y. A. S. M. E., M. E. L. A.

HOUGHTON, Charles Edwin, M.M.E., '94. Care Prof. C. B. Wing, Palo Alto, Cal.

HOUSTON, Claude Monroe, M.E., '17. Wisner, N. Y.

HOUSTON, Neill, M.E., '13. 14 W. Ave., Wellsboro, Pa.

HOVEY, William Simmons, M.E., '97. Gen. Supt. Car Co. 104 Main St., Three Rivers, Mich.

HOWARD, David Joseph, M.E., '17. 160 Park St., Buffalo, N. Y.

HOWARD, Frederick H. P., M.E., '03. 4741 Drover St., Chicago, Ill.
HOWARD, George Edwin, '93. Consulting Engr., Specialist Glass Industry. (1) (2) and (3) Butler, Pa.
HOWARD, J. Clare, M.E., '04. Franklinville, N. Y.
HOWARD, Nelson Webster, M.E., '07. G. Hall Coal Co. of Canada Ltd., (2) and (3) 126 St. Peter St., Montreal, Can. (1) 102 Fort St., Montreal, Can.
HOWARD, Otis Woolworth, M.E., '08. 2304 7 Ave., Moline, Ill.
HOWARD, Robert Vernon, M.E., '09. Eng. Draftsman. 30 N. Menard Ave., Chicago, Ill.
HOWARD, Walter, '96. Gen. Mgr. (2) and (3) Standard Optical Co., Geneva, N. Y. (1) 756 Main St., Geneva, N. Y.
HOWARTH, Harold Folsom, M.E., '09. R. F. D. 3, Ithaca, N. Y.
HOWE, Charles B., E.E., '03. Chairmen Industrial Education. (3) and (2) Bushwick High School, Brooklyn, N. Y. (1) Crestwood Ave., Yonkers, N. Y. (3) 400 Irving Pl., Brooklyn, N. Y.
HOWE, Charles Melville, M.E., '97. (2) and (3) 712 Peoples Gas Bldg., Chicago, Ill. (1) 2222 Lincoln St., Evanston, Ill.
HOWE, George, '94. North Salem, N. Y.
HOWE, Henry Lawrence, jr., M.E., '10. Asst. Engr. with city of Rochester, (2) and (3) Engrg. Dept., City Hall, Rochester. (1) 120 Chestnut St., Rochester, N. Y. Assoc. A. I. E. E., Roch. Eng. Soc.
HOWE, James McKechnie Lawrence, M.E., '08. Chief Engineer. (1) 2560 Overlook Rd., Cleveland, O. (2) and (3) Grant Motor Car Co., Cleveland, O. Soc. Auto Engineers.
HOWE, Ralph Sawyer, M.E., '14. 149 W. 93d St., New York, N. Y.
HOWE, Ralph Wilson, M.E., '08. 5851 Winsor Pl., Philadelphia, Pa.
HOWE, Samuel Purdy, '02. (2) and (3) Pres. Camden Forge Co., Camden, N. J.
HOWE, Thomas, M.E., '96. 2 Rector St., New York, N. Y.
HOWELL, Fred Boss, '15. 22 W. Ross St., Wilkes-Barre, Pa.
HOWELL, John B., M.E., '14. Draughtsman and Designer. (2) 147 Cedar St., New York City. (1) and (3) 412 Morris Ave., Boonton, N. J.
HOWELL, James Russell, '11. 36 Liberty St., Newton, N. J.
HOWELL, Newton Delaine, M.E., '10. Ludlowville, N. Y.
HOWELL, William G., '96. 207 E. Ohio St., Chicago, Ill.
HOWELL, William James, '10. Fall Brook Coal Co., Antrim, Pa.
HOWES, Edgar Hall, '96. Oil Bus. 337 N. Mathews St., Los Angeles, Cal.
HOWES, Robert, M.E., '98. 1102 Am. Bk. Bldg., Seattle, Wash.
HOWLAND, Clarence O., '06. Asst. Examiner, U. S. Patent Office, Washington, D. C. (2) and (3) 1364 Parkwood Pl., Washington, D. C.
HOWLAND, Frank C., M.E., '03. Treas. and Gen. Mgr., Thos. Phillips Co. T. P. Co., Akron, O. (3) (2) 115 S. Union St., Akron, O.
HOXIE, George L., M.M.E., '97. Cons. E. E., 50 Church St., New York City
HOXIE, Kinney C., M.E., '93. Minn. Steel Co., Nolvin Bldg., Duluth, Minn. 1422 E. 5th Ave., Duluth, Minn.
HOYT, Frank Watson, M.E., '08. 102 Lincoln Rd., Brooklyn, N. Y.
HOYT, Frank Wellington, M.E., '14. 14 Rose St., Danbury, Conn.
HOYT, Raymond Dudley, M.E., '03. 700 Journal Bldg., Portland, Ore.
HUBBARD, Charles Pitcher, '15. Engineer. (2) American Trading Co. Tokio, Japan. (1) and (3) 312 Bent Road, Wyncote, Pa.
HUBBARD, Tunis Thayer, M.E., '95. 5707 Carnegie Ave., Columbus, O.
HUBBARD, William Wiley, M.E., '97. 45 E. 17 St., New York, N. Y.
HUBBELL, Charles Wesley, M.E., '07. (1) 37 Fulton St., Pittston, Pa. (2) and (3) Lock Box 655, Stamford, Conn.
HUBBELL, Reed Hamilton, M.E., '05. 401 Brewster St., Saginaw, Mich.
HUBBY, Rollin Germain, '93. Architect. 619 Caxton Bldg., Cleveland, Ohio. A. I. A.
HUCK, Louis Charles, M.E., '17. 446 Diversey Parkway, Chicago, Ill.
HUDSON, Andrew James, M.E., '03. 202 W. 103d St., New York, N. Y.
HUDSON, Wilbur Gregory, M.E., '97. 140 Cedar St., New York, N. Y.
HUE, Harold Peirce, '06. 400 Market St., Warren, Pa.
HUFNAGEL, Frederick Bernhard, M.E., '00. (2) and (3) Supt. Aliquippa Works, Pittsburgh, Pa. (1) 531 N. Negley Ave., Pittsburgh, Pa.
HUGHES, Adrian, jr., M.E., '12. (1) 1315 N. Calvert St., Baltimore, Md. (2) and (3) 4104 Maine Ave., W. Forest Pk., Baltimore, Md.
HUGHES, Ernest Van, '11. 3d and Franklin Aves., Long Branch, N. J.
HUGHES, Henry Mallory, M.E., '13. 1136 Elk St., Franklin, Pa.
HUGHES, Oliver B., '11. 3d and Franklin Aves., Long Branch, N. J.
HUKILL, H. D., M.E., '16. Eng. Dept., Wilson Snyder Mfg. Co. (2) Pittsburgh, Pa. (1) and (3) 232 Home Ave., Avalon, Pa. A. I. E. E., Eng. Soc. of W. Penn.
HULETT, Gaylord De Forest, M.E., '91. Sodus, N. Y.
HULL, Harry Blair, M.E., '13. Care York Mfg. Co., York, Pa.
HULL, Howard Windsor, M.E., '92. Rooms 320-1 Real Estate Bldg., Scranton, Pa. 814 Columbus St., Scranton, Pa.
HULL, John Donald, M.E., '03. 354 Colman Bldg., Univ. Club, Seattle, Wash.
HUMBURCH, Raymond Sage, '09. Gen. R. R. Signal Co., Rochester, N. Y.
HUME, Fred, M.E., '05. Nashville, Tenn.
HUMMELL, Ferdinand George, M.E., '15. (2) Care Babcock & Wilcox Boiler Co., Bayonne, N. J. (3) and (1) 21 Linden St., Bayonne, N. J. A. S. M. E.
HUMPHREYS, Fred Arthur, '95. Lanes Mills, Pa.
HUNKINS, Darius Sydney, '04. Supt., Peerless White Lime Co., St. Genevieve, Mo.
HUMPSTONE, Harold Dunmore, '08. 291 Ryerson Ave., Brooklyn, N. Y.
HUNGER, Edwin Andrew, M.E., '11. Editorial Staff, New York, N. Y.
HUNT, Andrew Dickson, M.E., '05. 35 E. 31 St., New York, N. Y.
HUNT, Charles Wallace, jr., M.E., '12. M.M.E., '13. Howard Ave., Stapleton, N. Y.
HUNT, Sylvester Henry, '04. Chelsea Ave., Long Branch, N. J.
HUNT, William Floyd, M.E., '94. 115 Broadway, New York, N. Y.
HUNTER, Charles Welsh, M.E., '05. Engr. Stone & Webster. 147 Milk St., Boston, Mass.
HUNTER, John Alexander, M.E., '00. Steam Engr., Am. Sheet & Tin Plate Co., Frick Bldg., Pittsburgh, Pa. 151 Dicksien Ave., Ben Avon, Pa. A. S. M. E., Engr. Soc. of West. Pa., Am. Iron & Steel Inst.
HUNTER, Jay Tyler, '96. Lawyer. 1107-1113 Jefferson Bldg., Peoria, Ill.
HUNTER, Oscar Laurence, '97. 5412 East End Ave., Chicago, Ill.
HUNTER, Robert Williamson, '05. Accountant, Southern R. R. Co. Washington, D. C.
HUNTLEY, Harold Wood, '04. 1st Lieut., 3d Reg. U. S. Artillery, Fort Myer, Va.
HUNTING, Irving Adelbert, M.E., '02. 125 W. Fifth St., Plainfield, N. J.
HUNTINGTON, F. Dan., M.E., '00. Vice-President, John W. Cooper Co., Fidelity Bldg., Buffalo, N. Y. 5 Milton Manor, Buffalo, N. Y.
HUNTINGTON, Maurice Burt, M.E., '17. 24 Lake St., Pulaski, N. Y.
HUPE, Henry Lloyd, M.E., '09. 5th and Market Sts., Louisville, Ky.
HURD, Perry Elisha, M.E., '13. 5344 Wayne Ave., Germantown, Pa.
HURLBURT, Alfred, M.E., '97. 716 Gleed Terrace, Kansas City, Mo.
HURLBURT, Russell Blair, '10. (2) and (3) Export Dept., care Niles-Bement Pond Co., 111 Broadway, New York City. (1) 85 Crooke Ave., Brooklyn, N. Y.
HURLBUT, Charles Chase, '96. Architectural Engineer. (2) and (3) 101 Park Ave., New York City. (1) 97 Lincoln St., Montclair, N. J. A. S. C. E.
HURLBUT, John, M.E., '05. 601 Hector St., Ithaca, N. Y.
HURWITZ, William S., M.E., '11. Special Agent, Appraisal of Utilities for Special Franchise Valuation, State Tax Dept., Albany, N. Y. 524 Madison Ave., Albany, N. Y.
HUSSEY, Horace Potter, '75. Alpha Delta Phi Club, New York City.
HUSSEY, Thomas Ormond, M.E., '12. Sibley College, Ithaca, N. Y.
HUSTED, Clifford Mackay, M.E., '09. Asst. Supt. Eagle Wks., Standard Oil Co. 502 Garfield Ave., Jersey City, N. J.
HUSTIS, Roland Ludington, '07. 737 Marshall St., Milwaukee, Wis.
HUTCHINSON, Alfred Henry, M.E., '09. Factory Mgr. and Ass. Sec., Grand Crossing Track Co., 79th St., and S. Chicago Ave., Chicago, Ill. (1) 79 St. and S. Chicago Ave., Chicago, Ill. (2) and (3) 2322 E. 70th Place, Chicago, Ill. Western Efficiency Soc., Ill. Mfgs. Ass., Nat. Council for Industrial Safety.
HUTCHINSON, Frederick Lane, M.E., '93. Sec. American Institute of Electrical Engineers. 33 W. 39th St., New York City. Engineers Club of New York.
HUTTON, William Henry H., jr., '91. Detroit Axle Co., Detroit, Mich. 132 Clark Ave., Detroit, Mich.
HUYETT, Daniel Duhurst, M.E., '12. (2) and (3) Frick Co., Waynesboro, Pa. (1) 3d St., Waynesboro, Pa.
HYATT, Frank Reed, '12. 1st M. E. Bureau of Tests, International Paper Co. (2) Bureau of Tests, Intl. Paper Co., Glens Falls, N. Y. (1) and (3) 49 Elm St., Glens Falls, N. Y. Amer. Paper and Pulp Assoc.
HYDE, E. C., '16. 22 Pearne St., Binghamton, N. Y.
HYDE, Tom Bruce, M.E., '08. With Natl. Carbon Co. (3) and (2) Nat. Carbon Co., Cleveland, O. (1) 1262 Fry Ave., Cleveland, O. Cleveland Engineering Society.
HYLAND, Hosea Dexter, M.E., '14. (1) 47 King Ave., Weymouth, Mass. (2) and (3) Fore River Shipbuilding Co., Quincy, Mass.
HYNES, Francis Benedict, M.E., '10. Industrial Bureau, Eng. Dept. (2) Crocker-Wheeler Co., Ampere, N. J. (1) and (3) 76 Park Ave. E. Orange, N. J.
IDE, Francis Pierce, M. E. '92. Springfield, Ill.
IGLEHART, Eugene Worthington, '99. 5 Church Circle, Annapolis, Md.
IHLDER, Johann Diedrich, M.E., '87. Sect. Ellen Wilson Homes Co., Washington, D. C. 704 Union Trust Bldg., Washington, D. C. 250 11 Ave., New York City.
ILIFF, C. C., '16. 46 Trinity St., Newton, N. J.
ILLMER, Gustav Adolphus Marius, M.E., '09. Salzburger Strasse 11, Schaneberg, Berlin, Germany.
ILLMER, Louis, jr., M.E., '01. 117 Windsor St., Reading, Pa.
IMBRIE, William Morris, M.E., '04. (1) Signal Mt. Inn, Chattanooga, Tenn. (2) and (3) 61 Broadway, New York City.
INGERSOLL, George Talcott, '93. P. O. Box 791, Salt Lake City, Utah.
INGERSOLL, Howard Heberton, M.E., '15. With Atlantic Refining Co. 4008 Chestnut St., Philadelphia, Pa.
INGLEHART, Hiram Fred, '02. 47 Ten Eyck St., Watertown, N. Y.
INGLES, John, M.E., '97. Radford, Va.
INGRAHAM, William Shurtleff, '79. Bristol, Conn.
INGRAM, Harrison Arden, M.E., '11. Care Pub. Serv. Com. of N. I. Lacon, Ill.
INK, John Bakes, M.E., '12. Stone & Webster Co., or 147 Milk St., Boston, Mass.
INMAN, William Horace, M.E., '12. 2 Chestnut St., Amsterdam, N. Y.
INSLEE, Charles L., M.E., '96. (2) and (3) Pres. Guarantee Const. Co., 140 Cedar St., New York City. (1) Newton, N. J.
INSLEE, Russell Gage, '00. 136 W. 44th St., New York City.
INSULL, Martin John, M.E., '93. (2) Care Middle West Utilities Co., Loan and Trust Bldg., Chicago, Ill. (1) and (3) New Albany, Ind.
INSULL, William, '15. 198 Bartlett Ave., Pittsfield, Mass.
IRISH, Frederic Joseph, '06. 350 Ocean Ave.
IRISH, William Edward, M.E., '12. (1) 2735 E. Colfax Ave., Denver, Col. (2) Hydraulic Pressed Steel Co., Cleveland, O.
IRVINE, Pierpont Edward, M.E., '07. 6207 Kenwood Ave., Chicago, Ill.
ISBELL, Charles Woodruff, M.E., '16. 123 W. 81st St., New York City.
ISHAM, Edwin Schutt, '90. 27 W. 67th St., New York City.
ITO, Ichiro, M.E., '08. 9 Itchome, Tamachi, Asakusaku, Tokio, Japan.
ITTNER, Conrad Smithuran, '74. Brick Maker and Layer. 2603 Michigan Ave., St. Louis, Mo.
IVES, Kenneth Gaige, M.E., '12. 4724 Kenwood Ave., Chicago, Ill.
IVES, Paul Dunreath, '90. South Easton, N. Y.
IVES, Robert Austin, M.E., '02. (1) 204 N. Cayuga St., Ithaca, N. Y. (2) and (3) 361 Elm St., New Haven, Conn.
JACK, Harry Mathews, '06. 4 Elm St., Bradford, Pa.
JACKMAN, Edwin Thomas, M.E., '13. Salesman Firth Sterling Steel Co. (2) and (3) 710 W. Lake St., Chicago, Ill. (1) 4732 Wallingford St., Pittsburg, Pa.
Jackson, Carl Metcalf, M.E., '12. (3) and (1) 6 Onondaga Place, Syracuse, N. Y.
JACKSON, Frank Darwin, M.E., '92. 32 W. Genesee St., Buffalo, N. Y.
JACKSON, George Percy, M.E., '08. 910 Franklin Ave., Wilkinsburg, Pa.
JACKSON, Hiram Gardner, '99. 112 Prospect St., Waterbury, Conn.
JACKSON, Lucian Cornes, M.E., '91. Designer Pleasure Cars, Pierce Arrow Motor Car Co., Buffalo, N. Y. (2) and (3) 351 Hoyt St., Buffalo, N. Y. A. S. M. E.
JACKSON, Thomas Marshall, M.E., '08. Sales Engr., West. Elect. & Mfg. Co. (3) and (2) Widener Bldg., Philadelphia, Pa. (1) 301 S. Broad St., Kennett Square, Pa.
JACOBS, Arthur James, M.E., '12. Elec. Engr. Pub. Serv. Comm. (1) 584 W. 152 St., New York, N. Y. (2) 120 Broadway, New York City. (3) 618 W. 142 St., New York City. New York Elec. Soc.
JACOBS, Harold Halford, '10. Examiner, Patent Office. (2) Washington, D. C. (1) 95 Dickinson St., Springfield, Mass. (3) 2501 14th St., Washington, D. C.
JACOBS, Ward Sawtelle, M.E., '97. W. W. Jacobs Co., Hartford, Conn. 530 Farmington Ave., Hartford, Conn.
JAGGARD, Ernest Plack, M.E., '17. Altoona, Pa.
JAHN, Gustave Adolph, jr., '08, Columbia, '11. Mining Engr. (2) Rogers-Brown Iron Co., Hibbing, Minn. (1) 418 Garfield St., Hibbing, Minn.
JAMES, Arthur Evan, '10. The Lehigh Coal & Nav. Co., Lansford, Pa.
JAMES, Lewis Roscoe, M.E., '03. 655 Parker Ave., Braddock, Pa.
JAMES, Walter Rodney, M.E., '17, B.S. 320 Duncan Ave., Norfolk, Va.
JAMESON, Norris Morey, M.E., '11. 764 Potomac Ave., Buffalo, N. Y.
JAMISON, E. S., M.E., '16. 173 Glenwood Ave., E. Orange, N. J.
JANEWAY, John Livingston, '07. 309 S. 22d St., Philadelphia, Pa.
JANNEY, Walter Thompson, M.E., '01. R. F. D. 5, Carlisle, Pa.
JANOWITZ, Martin, M.E., '11. Chief Draftsman & Ass. Engr. (1) and (2) Care J. P. Devine Co., 1372 Clinton St., Buffalo, N. Y. (3) 387 Jefferson St., Buffalo, N. Y. Buffalo, Engrg. Soc.
JANSEN, Edward Walter, M.E., '07. Sec. and Treas., Engineering. Atlantic Welding Corp., 30 Church St. 203 West 81 St., New York City. Amer. R. Engr. Assoc., N. Y. R. R. Club, Amer. Elec. Chem. Soc.
JAWETZ, Harry, M.E., '15. 425 Wendover Ave., New York City.

JAYNE, Allen, M.E., '10. West Auburn, Pa.
JEFFERSON, Carl John, M.E., '10. Collingswood, N. J.
JEFFREY, Charles Louis, M.E., '93. 775 7th Ave., New York, N. Y.
JENKINS, David John, M.E., '92. Solvay Process Co., Detroit, Mich.
JENKINS, John Ethbert, M.E., '16. (3) Manhattan, Kans. A. I. E. E.
JENKS, Sidney Grant, M.E., '97. 815 Union St., Port Huron, Mich.
JENNEY, Isaac Hallam, '96. 60 Madison Ave., New York City.
JESSUP, George Penney, M.E., '08. Quoque, N. Y.
JEWELL, Charles Gordon, M.E., '06. 209 32d St., Newport News, Va.
JEWELL, Edward Winchell, M.E., '93. 1956 Robinson Ave., San Diego, Cal.
JEWETT, Frank Howard, '89. Unknown address.
JEWETT, Harold Frederick, M.E., '03. B. & A. Ry., Auburndale, Mass.
JOHN, G. A., jr., '07.
JOHNSON, Allen Chalfant, M.E., '12. 277 E. Mill St., Akron, O.
JOHNSON, A. Langstaff, M.E., E.E., '04. Consulting Engineer. (1) 505 W. Franklin St., Richmond, Va. (2) (3) 1216 Mutual Bldg., Richmond, Va. A. S. M. E.
JOHNSON, Arries Lyman, M.E., '12. Engr. International Paper Co. (1) (3) 1 Elm St., Cooperstown, N. Y. (2) Box 7, Palmer, N. Y.
JOHNSON, Ben, B.M.E., '78. (2) (3) Care United Railways' of Havana, Central Station, Havana, Cuba. Prado 44, Havana, Cuba.
JOHNSON, Charles Edward, '04. 752 E. Ridgeway St., Cincinnati, O.
JOHNSON, Charles Leo, M.E., '97. Western Elec. Co., Hawthorne, Ill.
JOHNSON, Chesley Heath, M. E. '07. Teacher. (2) Phila. Trades School., Philadelphia, Pa. (1) (3) 263 S. Felton St., Philadelphia, Pa.
JOHNSON, Charles W., M.E., '07. Salesman. (1) (3) 23 Kearny St., Newark, N. J.
JOHNSON, Eads, M.E., '99. Consulting Eng. and Naval Architect. (1) 7 Westover Rd., Montclair, N. J. (2) and (3) 30 Church St., New York City. A. S. M. E.
JOHNSON, Elisha Martin, '06. Field Eng. Producers Gas Co. (2) and (3) First Nat. Bank Bldg., Olean, N. Y.
JOHNSON, Frederic Ayres, '96. 1419 N. Tejon St., Colorado Springs, Col.
JOHNSON, Francis Porter, '97. Ridgway Dyn. & Eng. Co., Cincinnati, O.
JOHNSON, George Friedman, M.E., '07. Gen. Elec. Co., Detroit, Mich.
JOHNSON, George Tewksbury, M.E., '06. Mech. Engr., The Buckeye, Steel Castings Co., Columbus, Ohio. (1) 135 S. Garfield Ave., Columbus Ohio. (2) (3) Buckeye Steel Cast. Co., Columbus, O. Am. Soc. for Testing Materials. A. S. M. E.
JOHNSON, Harry Disbrow, jr., '04. Plant Engineer, Studebaker Corporation. 1013 E. Jefferson St., South Bend, Ind. A. S. M. E.
JOHNSON, Harvey Fletcher, M.E., '06. U. S. Coast Guard. (2) and (3) U. S. Custom House, Savannah, Ga. (1) 520 Maupas Ave., Savannah, Ga. Am. Soc. of Naval Engineers.
JOHNSON, Henry Smith, M.E., '99. Babylon, L. I., N. Y.
JOHNSON, Howard Spaford, E.E., '96. Char. Elec. Supply Co. (2) (3) 914 Kanawha St., Charlestown, W. Va. (1) 1204 Kanawha St., Charlestown, W. Va.
JOHNSON, Howard White, M.E., '07. 1821 W. 9 St., Spokane, Wash. 5817 Monroe Ave., Chicago, Ill.
JOHNSON, Jacob Burlin, M.E., '12. 116 N. 3 St., Olean, N. Y.
JOHNSON, John Thomas, jr., M.E., '09. Mgr. Cord Tire Dept. (2) B. F. Goodrich Co., Akron, O. (1) and (3) 702 E. Market St., Akron, O.
JOHNSON, Joseph Esrey, jr., M.M.E., '92. Consulting Engr. and Metallurgist, Hartsdale, N. Y. 52 William St., New York City. A. S. M. E., A. I. M. E., Am. Electro. Chem. Soc., British Iron and Steel Inst., Am. I. & S. Inst., Min. and Met. Soc.
JOHNSON, Nathan Clarke, M.E., '06. (1) 109 Lucerne Ave., Pittston, Pa. (2) and (3) 149 Broadway, New York City.
JOHNSON, Orson Tracy, M.E., '08. 36 Westmoreland Pl., Los Angeles, Cal.
JOHNSON, Paul Beekman, '07. 167 Main St., Easthampton, Mass.
JOHNSON, Paul Beekman, '10. Structural Engineer. (2) and (3) 33 Lyman St., Springfield, Mass. (1) Agawam, Mass. Masons and A. F. & A. M.
JOHNSON, Ralph William, '07. Unknown address.
JOHNSON, Ralph P., M.E., '12. Metallurgical Engr., The Remington Arms Co. of Delaware. (2) Eddystone, Pa. (3) 1421 Arch St., Philadelphia, Pa. Am. Soc. for Testing Material.
JOHNSON, Raymond Deloraine, M.E., '95. 60 Wall St., New York City.
JOHNSON, Simeon Ryerson, '97. Divernon, Ill.
JOHNSON, Theophilus, jr., '13. Student, '16. Elect. Engrg., Columbia Univ., 550 W. 114th St., New York City. (1) and (3) 17 Third St., Woodside, L. I., N. Y. Inst. of Radio Engrs.
JOHNSTON, Charles Watkins, '07. 23 Kearney St., Newark, N. J.
JOHNSTON, Edwin Christie, '04. 135 William St., New York City.
JOHNSTON, George Keith, '00. 18 Queensland Chambers, Bridge St., Sidney, N. S. W.
JOHNSTON, Harold Eddy, M.E., '02. Manufacturing. Cohoes Iron Foundry & Mach. Co., Cohoes, N. Y. (2) and (3) 546 Third Ave., North Troy, N. Y. Phi Beta Kappa, Sigma Xi.
JOHNSTON, James M. A., M.E., '06. Member of Firm, Carneal & Johnston, Architects & Engrs. (2) and (3) 707 Chamber of Commerce Bldg., Richmond, Va. (1) 1411 Geore Ave., Richmond, Va. A. S. M. E.
JOHNSTON, Richard Joseph, M.E., '12. Illuminating Engineer G. E. Co. (1) 805 Dorr St., Schenectady, N. Y. (2) and (3) Hotel Foster, Schenectady, N. Y.
JOHNSTON, Robert Marsh, M.E., '05. 554 Monroe Ave., Rochester, N. Y. 57 W. 2 St., Mansfield, O.
JOHNSTON, Roger Newton, M.E., '11. 694 E. Market St., Akron, O.
JOHNSTON, William Chester, '09. 388 Lake Ave., Rochester, N. Y.
JOHNSTON, Walter David, A.B., '17. Waukesha, Wis. Eta Kappa Nu, Tau Beta Pi.
JONAS, Milton Rudolph, '11. Steam Expert. Joliet Wks., Illinois Steel Co., Joliet, Ill. (3) and (2) 1109 Cass St., Joliet, Ill. A. S. M. E.
JONES, Arthur Lucas, '04. Dist. Engr. Gen. Elect. Co. (2) and (3) 936 1st Nat. Bank Bldg., Denver, Col. (1) 2330 Dexter St., Denver, Col. A. I. E. E., A. S. M. E.
JONES, Arthur Locke, '06. Mfgr. Agent, Brass and Copper Products. (2) and (3) 590 Ellicott Sq., Buffalo, N. Y. (1) 109 Ashland Ave., Buffalo, N. Y.
JONES, Calvin, M.E., '96. Selma, Ala. Piper, Bibb Co., Ala.
JONES, Clement Ross, M.M.E., '00. Box 851, Morgantown, W. Va.
JONES, Edward Tompkins, M.E., '11. Cornell Univ., Ithaca, N. Y.
JONES, Ernest Wilbur, M.E., '06. 61 Highland Ave., Buffalo, N. Y.
JONES, Forrest Robert, M.E., '88. 1702 Melrose Pl., Knoxville, Tenn.
JONES, Frank Henry, M.E., '09. Care Jackson Elec. Ry. Light & Power Co. Jackson, Miss.
JONES, Fred Atwood, M.E., '98. Unknown address.
JONES, Gordon Holmes, M.E., '12. 3059 Villa Ave., New York, N. Y.
JONES, Grover Haughton, M.E., '08. Elec. Dept. Pacific Elec. Ry., Los Angeles, Cal.
JONES, Harold Colbert, M.E., '02. 4808 Dorchester Ave., Chicago, Ill.
JONES, Ira Owen, '06. Asst. Gen. Supt. (2) and (3) Wisconsin Steel Co., S. Chicago, Ill. (1) 6556 Woodlawn Ave., Chicago, Ill.
JONES, Isaac Seeley, M.E., '06. 1159 Humphrey Ave., Oak Park, Ill.
JONES, John Lucien, '06. 150 N. Market St., Chicago, Ill.
JONES, John Paul, '13. (1) 1247 Hinman Ave., Evanston, Ill. (2) and (3) American Steel Foundries, Chicago, Ill.
JONES, John Thompson, '13. Address unknown.
JONES, Lloyd Balderston, M.E., '04. (1) and (3) Westgrove, Pa. (2) 33 N. High St., Columbus, Ohio.
JONES, Malcolm Sleight, '10. Sun Co., Marshall Bldg., 40 Central St., Boston, Mass.
JONES, Marshall Teel, M.E., '13. Care Standard Oil Co., Hong Kong, China.
JONES, Melvin Elijah, M.E., '98. El Paso, Texas.
JONES, Paul Sherwood, '05. 10 Armory St., Ilion, Ill.
JONES, Reid, M.E., '10. Contracting and Consulting Engrs. (1) 2125 River Ave., San Antonio, Texas. (2) and (3) Thomas & Jones, 611 Brady Bldg., San Antonio, Texas. Ass. Mem. A. S. M. E., A. I. E. E.
JONES, Roger Cleaveland, '17. Collinsville, Conn.
JONES, Richard Oscar, '90. Cor. Rass and River Sts., Wilkes-Barre, Pa.
JONES, Robert J., M.E., '13. Asst. Engr. Turbine Dept., Gen. Elec. Co. (2) 179 Parrish St., Wilkes-Barre, Pa. (1) and (3) 90 S. Common St., Lynn, Mass. A. S. M. E.
JONES, Roy Williams, M.E., '15. 341 Vine St., Johnstown, Pa.
JONES, Sebastian Chatham, '90. Supt. N. Y. Military Academy, Cornwall-on-Hudson, N. Y.
JONES, Sherman, '05. Hamilton, N. Y.
JONES, Thaddeus Merrick, '97. 501 W. 139 St., New York City.
JONES, Theodore Inslee, '96. Sales Manager, Edison Illuminating Co., Brooklyn, N. Y.
JONES, T. R., '17. Eagle Pass, Tex. A. I. E. E.
JONES, William Joseph, M.E., '99. 112 Cathedral Parkway, New York, N. Y.
JORDAO, Benvenuto, '78. Sao Paulo, Brazil.
JOSEPH, Edward Nichols, '01. 514 Neville St., Pittsburg, Pa.
JOSEPH, John Arthur, M.E., '08. (1) 17 Southampton St., Buffalo, N. Y. (2) and (3) 411 West End Ave., New York, N. Y.
JOSEPHY, Alvin, M.E., '08. Woodmere, L. I., N. Y.
JOSLYN, Raymond Elbert, M.E., '05. 5037 Irving St., W. Philadelphia, Pa.
JOY, John Marston, '90. Care American Press Association. 225 W. 39th St., New York City.
JOYCE, Harry Burkert, M.E., '12. (2) The United Electric Light & Power Co., 130 E. 15th St., New York City. (1) 81 Columbia Heights, (3) Brooklyn, N. Y.
JUDSON, Edward Dougald, '14. Fidelity Bldg., Tacoma, Wash.
JUDSON, Lyman Collins, M.E., '10. Care Enos Judson Co. Box 147, Ocean Park, Cal.
KABLE, G. B., M.E., '16. 6 5th Ave., New Brighton, N. Y.
KAFFENBERGER, Karl Gustave, M.E., '13. Asst. Gen. Supt. Office, Pierce Arrow Motor Co. (2) 1695 Elmwood Ave., Buffalo, N. Y. (3) and (1) 33 Berkley Place, Buffalo, N. Y. Buffalo Engineering Soc.
KAHL, William, M.E., '06. 321 Monroe Bldg., Chicago, Ill.
KAHN, Albert M., M.E., '09. Stove Mfgr. (3) and (2) Care The Estate Stove Co., Hamilton, O. (1) 14 Greenwood Court, Cincinnati, O.
KALBFUS, Joseph Barnett, M.E., '17. 3068 Q St., Washington, D. C.
KALB, Lewis Powell, '10. Chief Engineer, Kelly Springfield Motor Truck Co. (2) and (3) 1112 E. Hight St., Springfield, Ohio.
KAMMERER, William Charles, M.E., '17. (1) 2622 Tennessee Ave., St. Louis, Mo. (2) and (3) The Texas Co., Port Arthur, Tex.
KASFER, William Henry, M.E., '14. 545 Ridge Ave., Evanston, Ill.
KASTNER, Joseph, jr., '12. Mgr. of Jno. Thompson Press Co. (2) and (3) 426 S. Dearborn, Chicago, Ill. (1) 4415 Hazel Ave., Chicago, Ill.
KATTE, Edwin Britton, M.M.E., '94. Chief Engr. Electric Traction, N. Y. C. R. R. Co. (2) and (3) Grand Central Terminal, New York City. Irvington-on-Hudson, N. Y. A. I. E. E., A. S. M. E., Am. Ry. Assn., Am. Elect. Ry. Assn., N. Y. R. R. Club, N. Y. Elec. Society.
KATZENSTEIN, Martin Leopold, M.E., '02. 115 Broadway, New York, N. Y.
KATZENSTEIN, William, M.E., '03. Sec. L. Katzenstein Co., 358 West St. 55 West 95th St. New York City.
KEARNEY, Oliver Graham, jr. '12. Leetonia, O.
KEEFE, Robert Edwin, M.E., '17. (1) and (3) 433 E. Butchell Ave., Akron, O. (2) Goodyear Tire and Rubber Co., Akron, O.
KEELER, Coleman Clark, M.E., '10. 1602 Lytton Bldg., Chicago, Ill.
KEELER, George G., '07. General Insurance. (2) 307 Granby Bldg., Cedar Rapids, Ia. (1) 852 2d Ave. E., Cedar Rapids, Iowa. (3) P. O. Box 865, Cedar Rapids, Iowa. Kappa Sigma, Masque, Cor. Glee Club.
KEELY, Royal Rockwood, M.E., '00. 1702 Mt. Vernon St., Philadelphia, Pa.
KEELER, Ralph W., '07. Mgr. Miller Car Co., 129 Selden Ave., Detroit, Mich.
KEENAN, Walter M., M.E., '11. Mech. Eng. Dept., N. Y. Edison Co. (2) 130 E. 15th St., New York City. (1) and (3) 138 St. James Place, Brooklyn, N. Y.
KEESE, Jefferson L., '13. Sta. Barbara, Sao Paulo, Brazil.
KEET, Clarence Truman, M.E., '15. 4323 Walnut St., Philadelphia, Pa.
KEHL, Lester Henry, M.E., '00. 241 McKee Pl., Pittsburgh, Pa.
KELH, Robert Joseph, M.E., '12. Mech. Eng., Oxweld Acetylene Co. (1) 7141 Normal Ave., Chicago, Ill. (2) and (3) 3642 Jasper Place, Chicago, Ill. A. S. M. E., A. I. E. E.
KEELER, Alexander William, '14. (1) and (3) 60 Bedford St., Stamford, Conn. (2) Richards & Co., Stamford, Conn.
KELLER, Clifford Henry, M.E., '15. 1023 South Ave., Rochester, N. Y.
KELLER, George Meinhard, M.E., '08. Crown Cork & Seal Co., Baltimore, Md.
KELLER, William Henry, M. E. '94. Eccles, W. Va.
KELLER, Frank Perry, M.Arch., '91. Monongahela, Pa.
KELLEY, Frederick Williams, M.E., '93. 100 State St., Albany, N. Y.
KELLEY, Walter Furman, M.E., '99. 20 Laurel Ave., Walnut Beach, Milford, Conn.
KELLEY, William Vincent, jr., M.E., '93. 516 Eagle Block, Spokane, Wash.
KELLY, Andrew Park, M.E., '10. 325 Calvert Bldg., Baltimore, Md.
KELLY, Charles Wallace, M.E., '81. 342 Franklin Ave., Cleveland, O.
KELLY, James Bernard, M.E., '05. 316 Quincy St., Scranton, Pa.
KELLY, Joseph Thomas, jr., M.E., '02. Box 456, Baltimore, Md.
KELLOGG, Alfred Ostrom, '03. Kinderhook, N. Y.
KELLOGG, Charles Frederick, '97. Athens, Pa.
KELLOGG, Harry Whiting, '84. 19 Highland Ave., Greenfield, Mass.
KELLOGG, James Gifford, M.E., '06. Aberdeen and Adams St., Chicago, Ill.
KELLOGG, Wallace Osborne, M.E., '06. Sales Engr. (2) and (3) Gen. Elect. Co., Witherspoon Bldg., Philadelphia, Pa. (1) 147 Evergreen Ave., Woodbury, N. J.
KELSEY, Arthur Townsend, M.E., '91. Mecklenburg, N. Y.
KELSEY, Charles A., M.E., '01. Engr. (2) Gen. Elect. Co., Schenectady, N. Y. (1) and (3) 70 Bedford Rd., Schenectady, N. Y. A. I. E. E.
KELSEY, Walter, M.E., '97. 600 W. 163 St., New York, N. Y.
KEMP, William James, '01. Troy, N. Y.
KENDALL, Leroy Allen, M.E., '96. 376 Massachusetts Ave., Buffalo, N. Y.
KENDRICK, William Dixon, M.E., '07. Y. M. C. A., San Francisco, Cal.

KENLY, Edward Barry, jr., M.E., '13. 308 Otterman St., Greensburg, Pa.

KENYON, Jared Shotwell, M.E., '07. (2) and (3) Duplex Metallic Co., Conshohocken, Pa. (1) 757 W. 7th, Plainfield, N. J.

KENNEDY, Alexander, jr., M.E., '07. General Electric Co. (2) Schenectady, N. Y. (1) and (3) 225 Union St., Schenectady, N. Y.

KENNEDY, Clarence H., M.E., '12. New York Manager, The Kennedy Valve Mfg. Co., 81 John St., New York City. (1) 312 Haven Ave., New York City. (2) and (3) 81 John St., New York City.

KENNEDY, Charles Morehouse, M.E., '09. 834 Chamber of Commerce, Buffalo, N. Y.

KENNEDY, Jerome Doubleday, M.E., '98. Western Elec. Co. 424 Church Lane, Germantown, Philadelphia, Pa.

KENNEDY, Walter Critchlow, M.E., '07. 2211 Farmers Bank Bldg., Pittsburg, Pa.

KENNEDY, William Edward, M.E., '12. 336 A Hancock St., Brooklyn, N. Y.

KENNEWEG, Albert Henry, M.E., '04. 6201 Howe St., Pittsburg, Pa.

KENT, George Ervin, M.E., '10. Schoellkopf Bldg., C. U., Ithaca, N. Y.

KENT, Philip James, M.E., '14. Western Elec. Co., San Francisco. 6410 Farrell St., San Francisco, Cal.

KENT, Russell Hathaway, M.E., '12. Junior M. E., N. S. D. A. (2) Bureau Chemistry. (1) and (3) 54 R. I. Ave., N. W., Washington, D. C.

KENT, Stanley Burns, M.E., '11. (1) and (3) 53 Vermilyea Ave., New York, N. Y. (2) Care Western Elec. Co., 463 West St., Room 1063, New York City. A. I. E. E., Tau Beta Pi, A. I. E. E.

KENT, Winthrop, M.E., '15. 249 Huntington Rd., Bridgeport, Conn.

KENYON, Otis Allen, M.E., '04. Hastings-on-Hudson, N. Y.

KEPHART, Edwin Murray, M.E., '03. Stone & Webster Co., Boston, Mass. 147 Milk St., Boston, Mass.

KEPPEL, William Malcomson, '10. (2) Hubbard & Floyd, 80 West St., New York City. (1) and (3) 11 Cambridge Pl., Brooklyn, N. Y.

KERLIN, Ward Six, M.E., '01. Camden Forge Co., Camden, N. J. 314 State St., Camden, N. J.

KERR, Duncan Macmillan. Anaconda, Montana.

KERR, James Lyle, M.E., '14. Care W. Shakelford & Co., Baltimore, Md.

KERR, Nathaniel Morris, M.E., '14. (1) 81 Bay View Ave., Northport, N. Y. (2) and (3) Eng., Chas. F. Noyes Co., Bldg. Management, 92 William St., New York City.

KESSLER, Armin George, M.M.E., '10. (2) and (3) Gen. Mgr. Lakeside Forge Co., Erie, Pa. (1) 910 Chestnut St., Erie, Pa. Tau Beta Pi, Sigma Xi, A. S. M. E.

KESSLER, Herbert Herman, M.E., '13. Atlas Portland Cement Co., Hannibal, Mo.

KESSLER, John Edwin, M.E., '12. Carnegie Steel Co., Pittsburgh, Pa. 6038 Jackson St., Pittsburg, Pa.

KETCHAM, Harry Burton, M.E., '05. Edwardsburg, Mich.

KETCHUM, Lawrence Temple, '04. 375 W. Gray St., Elmira, N. Y.

KEY, Benjamin Franklin, M.E., '09. (2) Technical Writer, Westinghouse Air Brake Co., Wilmerding, Pa. (1) and (3) 515 Todd St., Wilkinsburg, Pa.

KEYSER, Mathew Brady, M.E., '93. 119 Montague St., Brooklyn, N. Y.

KIESECKER, Julius Henry Philip, M.E., '96. 2904 West Ave., Newport News, Va.

KIGER, E. E., '98. Box 216, Hamburgh, N. Y.

KILBURN, Edward Douglas, M.E., '05. 88 Cold Spring St., New Haven, Conn.

KILLIANI, Richard Bayard Taylor, '06. 116 E. 57, New York City.

KILLE, Houseman Maling, M.E., '13. 21 W. Madison Ave., Collingswood, N. J.

KILLICK, Frank Roy, M.E., '11. Lyons, N. Y.

KIMBALL, Clinton, M.M.E., '94. Mech. Engr. Vinegar Hill Zinc Co., Platteville, Wis. (1) (2) and (3) 508 W. Pine St., Platteville, Wis. A. S. M. E.

KINCAID, Charles Frank. Eureka Springs, Ark.

KING, Alexander Henderson, M.E., '15. 560 W. Broadway, New York City.

KING, Charles Brady. 814 Jefferson Ave., Detroit, Mich.

KING, Edwin Parker, '01. 123 South St., Painesville, O.

KING, Eugene Whittaker, M.E., '97. Mech. Engineer. (1) and (3) 1169 Belvere Ave., Syracuse, N. Y. (2) Semet Solvay Co., Syracuse, N. Y. A. S. M. E.

KING, Robert Peppenell, M.E., '12. Plant Eng. for New Eng. Westinghouse Co. (2) East Springfield, Mass. (1) and (3) 31 Clarendon St., Springfield, Mass. A. I. E. E., A. A. A. S.

KING, W. Grant, '94. Pres. King Sewing Mach. Co. (2) and (3) King Sewing Machine Co. Rano & Welland Sts., Buffalo, N. Y. (1) 101 Chapin Parkway, Buffalo, N. Y. A. S. M. E.

KING, Warren Griffen, M.E., '17. 2573 Stratford Rd., Cleveland, O.

KING, William Walter, M.E., '77. Huntsburg, O.

KINGSBURY, Albert, M.E., '89. Constructing Engineer. (1) (2) and (3) 219 Stratford Ave., Pittsburgh, Pa. A. S. M. E., A. A. A. S., S. P. E. E., A. I. E. E., Sigma Xi.

KINGSBURY, John McLean. 1409 4th Ave., North, Great Falls, Mont.

KINGSLAND, Roger Leverich, M.E., '05. Fairmont & Clarksburg Traction, Fairmount, W. Va.

KINGSLEY, Charles Francis, M.E., '00. 94 Neptune Pk., New Rochelle, N. Y.

KINNE, Charles Howell, '12. Ovid, N. Y.

KINNEY, Brewster Pelton, M.E., '01. Kinney & Levan, Cleveland, O. 60 Madena St., Cleveland, O.

KINNEY, Ely Merrick, M.E., '99. (2) G. E. Co., Schenectady, N. Y. (1) and (3) 212 Parkwood Blvd., Schenectady, N. Y. I. R. E.

KINNEY, Price W., M.E., '06. (2) and (3) Works Mgr., Atlas Tack Co., Fairhaven, Mass. (1) 33 Laurel St., Fairhaven, Mass, care The Atlas Tack Co.

KINSEY, Eugene Abbott, '00. La Salle, N. Y.

KINSLEY, Carl, M.E., '94. Univ. of Chicago, Chicago, Ill.

KINSLEY, Harold S., M.E., '14. Engr. (2) and (3) Cutler Hammer Mfg. Co., Milwaukee, Wis. (1) 2432 Wells St., Milwaukee, Wis.

KINSLEY, William Wirt, M.E., '01. Asst. Chf. Inspector, Wire and Cable Mfg. (1) and (3) 476 Victoria Ave., Westmount, Canada. (2) Northern Electric Co., Ltd., Montreal, Can. A. I. E. E.

KINSMAN, Cyrus Hillman, M.E., '05. Dodge Bros., Detroit, Mich.

KIPP, Roy Henry, M.E., '03. Springfield, O.

KIRBS, George J., M.E., '95. Supt. Mines. (1) Somerset, Pa. (2) and (3) Kimmelton, Pa. Am. Inst. of Mech. Eng., Mining Inst. of Am.

KIRBY, Robert Ward, M.E., '93. Urbana, O.

KIRK, Albert Edward, M.E., '99. 5821 Fifth Ave., Pittsburgh, Pa.

KIRK, Allen Taylor, '99. 901 Lawrence Ave., Chicago, Ill.

KIRKMAN, John, M.E., '12. Care Gen. Elec. Co., Chicago, Ill.

KIRKLAND, John Wilkinson, M.E., '89. Gen. Elec. Co., Johannesburg, S. Africa.

KIRKUP, Harold Benjamin. 215 W. 23, New York City.

KIRLEY, Wm. Winant, M.E., '91. 911 Third Ave., Utica, N. Y.

KISSICK, Joseph, jr., M.E., '06. 458 W. 143 St., New York, N. Y.

KITCHELL, Stanley, M.E., '06. Tamaqua, Pa.

KITTRELL, James Elwell, M.E., '15. 82 Plymouth Ave., Rochester, N. Y.

KITTREDGE, Joseph Powers, M.E., '02. Natl. Malleable Co., Sharon, Pa. 29 Euclid Ave., Sharon, Pa.

KLEINERT, E. W., M.E., '16. 523 3d St., Brooklyn, N. Y.

KLEIN, Richard Marcus, M.E., '98. 425 Bayway, Elizabeth, N. J.

KLEPSER, Clarence Maurer, '11. 49 Stevenson St., Seneca Falls, N. Y.

KLINCK, Fred Edgar, M.E., '10. Cornell Univ., Ithaca, N. Y.

KLINCK, John Henry, M.E., '94. 134 Broad St., Charlestown, S. C.

KLINE, Walter Joseph, '96. 186 Pine St., Lockport, N. Y.

KLING, Herbert Allen, M.E., '06. Woodbine, Iowa.

KLOCK, Frank Barnes, M.E., '99. 216 N. Lowell Ave., Syracuse, N. Y.

KLOCK, Frederic Adam, M.E., '02. St. Johnsville, N. Y.

KLUGE, Ernest John Jacob, M.E., '13. Mgr. Workmen's Compensation Bur. 542 Masonic Bldg., Portland, Me.

KNAP, Herschel Blake, M.E., '11. 56 Chandler, Detroit, Mich.

KNAPP, Arthur, '07. Production Supt., Petroleum Mining. (2) Baker Russian Pet. Co., Baker, South Russia. (1) and (3) 116 Ardmore Ave., Ardmore, Pa. A. I. Mining Engrs.

KNAPP, Edwin Curtiss, M.E., '90. 180 Furman, Schenectady, N. Y.

KNAPP, Isaac Newton, M.E., '75. 116 Ardmore Ave., Ardmore, Pa. A. I. M. E., Am. Gas. Inst.

KNAPP, Leland Garfield, M.E., '04. St. Paul & Tacoma Lumber Co., Tacoma, Wash.

KNAPP, Paul, M.E., '17. Chemist. (1) and (3) 116 Ardmore Ave., Ardmore Pa. (2) Eastern Lab., Chester, Pa. Alembic.

KNAPP, Ralph, M.E., '15. Operating Dept., Tenn. Copper Co. (1) 116 Ardmore Ave., Ardmore, Pa. (2) (3) Tenn Copper Co., Copperhill, Tenn.

KNAPP, Walter, '10. Supt. Shops, Lee Courteney Co. (2) 5 Maine St., Newark, N. J. (1) 116 Ardmore Ave., Ardmore, Pa. (3) 161 North 14th St., E. Orange, N. J. Tau Beta Pi.

KNIBLOE, R., '10. Post and Mason Sts., San Francisco, Cal.

KNICKERBACKER, John, M.E., '87. Waterford, N. Y.

KNIGHT, Alfred Henderson, M.E., '01. (2) and (3) Dodge Bros., Detroit, Mich. (1) 1885 Second Ave., Detroit, Mich. A. S. M. E., S. A. E.

KNIGHT, A. Thomas, M.E., '12. 34 Boynton St., Worcester, Mass.

KNIGHT, Howard Ashby, M.E., '16. 171 Church St., Putnam, Conn.

KNIGHT, Percy Henry, M.E., '92. 27 Chestnut St., Wilkinsburg, Pa.

KNIGHT, Seymour, '99. 17 Second Ave., Troy, N. Y.

KNIGHT, Theodore C., M.E., '05. Care Hon. E. C. Knight, Buffalo, N. Y.

KNISKERN, Walter Hamlin, '04. 323 N. Geneva, Ithaca, N. Y.

KNOWLSON, James Somerville, 3d, M.E., '05. Western Springs, Ill.

KNOX, Herbert, M.E., '02. 1409 Berger St., Pittsburg, Pa.

KOPLENZER, Hugo. New Brunswick, N. J.

KOCH, Marshal McKinley, M.M.E., '14. Care Hy. P. Doherty & Co., 60 Wall St., New York City.

KOENIG, F. W., '16. Thos. Kilpatrick & Co., Omaha, Neb.

KOENIG, Harry Lee, M.E., '03. Houston, Texas.

KOEHLER, Herbert Oscar. Dain Mfg. Co., Ottumwa, Iowa. 104 E. Locust, Davenport, Ia.

KORBER, Albert, jr. 103 Lincoln Pl., Brooklyn, N. Y.

KOHLER, Geo. Melvin, M.E., '02. Solvay Process Co., Syracuse, N. Y.

KOLLOCK, Frederick Nash, M.E., '97. 206 Central Bldg., Seattle, Wash.

KONSTANKEWICZ, Michael John, M.E., '10. 298 Park St., Springfield, Mass.

KOON, Sidney G., M.M.E., '03. Publicity and Consulting Engr. (2) and (3) Norton & Bird, Consulting Engrs., Chicago, Ill. (1) 8 Irvington St., Boston, Mass.

KOSTER, John William, '06. 115 Locust Ave., Yonkers, N. Y.

KOSITZKY, Gustavus Adolphus, M.E., '05. Gates Bldg., Kansas City, Mo.

KOSMINSKY, Isaac Joseph, M.E., '07. Care G. Less, Texarkana, Tex.

KOTHE, G., M.E., '07. Address not known.

KOUYOUMDJIAN, Haroutine, M.E., '06. Kemco Elec. Co., Cleveland, O. 2229 Ashland Rd., Cleveland, O.

KRAMAR, David Glenn, M.E., '15. Silsbee, Cal.

KRAEMER, Milton, M.E., '07. 209 Pine, San Francisco, Cal.

KRAEMER, Waldo Lawrence, M.E., '12. 620 Greene Ave., Brooklyn, N. Y.

KRAMER, George Howard, M.E., '02. 128 N. Grafton Ave., Dayton, O.

KRAMER, W. J., jr., '13. Address not known.

KRAMMES, Russell Ruess, M.E., '09. 104 Clinton Ave., Tiffin, O.

KRANZ, William George, M.E., '94. Vice-Pres. in charge of mfg. (1) 2600 Norfolk Rd., Cleveland, Ohio. (2) and (3) The Nat. Malleable Castings Co., 7706 Platt Ave., Cleveland, O. A. S. M. E., A. S. T. N.

KRASS, Ralph William, M.E., '06. 320 E. 57 St., New York, N. Y.

KRATZ, George Davenport, M.E., '12. Chemist. (1) and (3) 26 West Ave., Norwalk, Conn. (2) Norwalk Tire & Rubber Co., Norwalk, Conn. Am. Chem. Society.

KRAUS, George Augustus, M.E., '93. Clarence, N. Y.

KRAUSE, Ralph Ulysses, M.E., '08. 134½ 14 St., Milwaukee, Wis.

KRAUTER, Harold Storm, M.E., '07. 1409 Pine St., Scranton, Pa.

KREBS, Augustus Peter Sonnin, M.E., '00. (1) Wilmington, Del. (2) and (3) Krebs Pigment & Chem. Co., Newport, Del.

KREBS, Frederick Walters, '12. (2) and (3) Cambria Steel Co., Johnstown, Pa. (1) 509 Napoleon St., Johnstown, Pa.

KREBS, George Jacob, M.E., '92. Somerset, Pa.

KREHBIEL, Frederick August, M.E., '01. Pres. Krehbiel Co., Engr. and Contrs. (2) and (3) 1712 Marquette Bldg., Chicago, Ill. (1) 188 N. Lincoln St., Hinsdale, Ill.

KREIDER, Andrew Raymond, '03. Annville, Pa.

KRESS, Carl F., jr., M.E., '92. 713 Penn. Ave., Pittsburgh, Pa.

KRESS, James Edward, M.E., '91. Formerly Engr. of Tests, Cambria Steel Co. (2) and (3) Merchants Hotel, Johnstown, Pa. (1) 534 Locust St., Johnstown, Pa.

KRETZ, Charles Henry, '98. Baton Rouge, La.

KRIEBEL, Septimus Cassel, '94. 1755 Elmore St., Cincinnati, O.

KRIEG, Wm. Eugene, M.E., '15. Woodhaven, N. Y.

KRITZER, H. E., M.E., '14. 5514 Hyde Park Blvd., Chicago, Ill.

KRONENBERG, Otto Fuchs, M.E., '09. 100 Norwood Ave., Buffalo, N. Y.

KROTZ, G. D., M.E., '11. 26 West Ave., Norwalk, Conn.

KROUSE, Robert Louis, 223 Warburton Ave., Yonkers, N. Y.

KRUM, Lawrence Augustus, M.E., '96. Elec. Engr., Hudson River State Hospital, Poughkeepsie, N. Y. 20 Fairview Ave., Poughkeepsie, N. Y. (3) Hudson River State Hospital, Poughkeepsie, N. Y.

KRUMBHAAR, Hugh Montgomery, M.E., '03. Garden City, L. I., N. Y.

KRUTTSCHNITT, John, M.E., '10. 1218 N. State St., Lincoln Pk. Sta., Chicago, Ill.

KUEHMSTED, Albert Louis, M.E., '05. 2748 Hampden Ct., Chicago, Ill.

KUHLKE, George Oswald, M.E., '14. (2) and (3) Garvin Mach. Co., New York City. (1) 66 Ocean Ave., Brooklyn, N. Y.

KUHLMEY, Walter Andrew, '05. 921 Buena Park Terrace, Chicago, Ill.

KUHN, George Willifred, M.E., '05. 471 Willoughby Ave., Brooklyn, N. Y.

KUHN, Joseph, M.E., '92. 5217 16th Ave., N. E., Seattle, Wash.

KUHN, Walter William, M.E., '09. 1404 Broadway, Indianapolis, Ind.

KUHNE, Frederick, M.E., '11. Knauth, Nachod & Kühne, 13 Williams St., New York City.
KUNTZ, Wellington Wesley, '97. Truchlers, Pa.
KUNZE, Edward Joseph, M.E., '01. 512 Elm, Stillwater, Okla.
KURTZ, William Overton, M.E., '05. Engr. N. Y. Tel. Co. (2) and (3) 15 Dey St., New York City, Room 1400. (1) 123 Gordonhurst Ave., Upper Montclair, N. J.
KUSCHKE, Harry Travor, '03. 311 S. Hyde Pk. Ave., Scranton, Pa.
KUTNER, Sidney D., M.E., '11. Asst. Engr. Elec. Power Dept., N. Y. C. R. R. Co. (1) and (3) 600 W. 165th St., New York City. (2) Room 1611, Grand Central Terminal. A. I. E. E.
LACHICOTTE, Walter Betts, M.E., '02. 187 Broadway, New York, N. Y.
LACY, George Stuart, '04. Care Pacific Hardware & Steel Co., San Francisco, Cal.
LACK, Fred Sevier, '16. Proprietor, Lack Mfg. Co. (2) and (3) 1200 S. 3d St., Paducah, Ky. (1) 920 Jefferson St., Paducah, Ky.
LADD, George Tallman, M.E., '95. Pres. The George T. Ladd Co. (1) 5428 Baum Boulevard, Pittsburg, Pa. (2) and (3) 1620 Farmers Bank Bldg., Pittsburg, Pa. A. S. M. E.
LADD, Walter Manning, M.E., '06. 527 Auburn Ave., Buffalo, N. Y.
LaFEVER, George Allen, '12. (2) and (3) Care C. M. Rumlly Co., Battle Creek, Mich. (1) 52 Marshall St., Battle Creek, Mich.
LAFFERTY, Herbert Ray, M.E., '11. (2) and (3) Sec. Red Jacket Mfg. Co., Davenport, Ia. (1) 38 Oak Lane, Davenport, Ia.
LAIN, David Emmett, B.S., M.E., '85. 514 Franklin St., Pt. Townsend, Wash.
LAIN, William Kinne, '89. Principal, Port Jervis, N. Y.
LAING, Geo. Stuart, '01. (2) and (3) Asst. Mgr. Chile, West India Oil Co., Valparaiso, Chile. (1) Casilla 809. A. I. E. E.
LAJOUS, Adrian René, '11. Address unknown.
LAKE, Chauncey Frank, jr., '96. Lakeside, O. Kelley Is. Line & Trans. Co., Marblehead, O.
LAKE, Charles William, M.E., '14. Draftsman. (1) 739 Camanche Ave., Clinton, Ia. (2) and (3) H. Mueller Mfg. Co., Decatur, Ill. A. S. M. E.
LALEY, Robert Edward, M.E., '13. Care Workmen's Compensation Service Bldg.
LALLY, Clarence Vincent, '10. (1) Cornell Club, New York City. (2) and (3) Care Natl. Tube Co., 65 Park Ave., New York City.
LALLY, Ralph Richard, M.E., '08. 420 R. A. Long Bldg., Kansas City, Mo.
LAMAR, Philip Rucker, M.E., '02. Engineer. The Hill, Augusta, Ga.
De LAMATER, Van Ness, M.E., '00. Asst. Sales Mgr., Hyatt Roller Bearing Co., Detroit, Mich. (1) (2) and (3) 3066 Gr. Boulevard, W., Detroit, Mich. A. S. M. E., N. Y. R. R. Co., Jovians.
LAMB, Roy Dane, '06. Los Gatos, Cal.
LAMB, Emmrich David, '15. Apt. 42, 2518 17th St., Washington, D. C.
LAMB, Robert Scott, '07. Physician. The Cecil, Washington, D. C.
LAMB, Henry Cleaveland, M.E., '03. River Rd., Bogota, N. J.
LAMBERT, Estern Russell, '11. Gen. Mgr., Southern Cotton Compress Co. (1) (2) (3) Monticello, Ark.
LAMBERT, T. B., (Bennett, DeVillo Levi), '87. 3342 Walnut St., Chicago, Ill.
LAMPERT, James Gillespie Blaine, M.E., '13. Care War Dept., Washington, D. C. (Temp.) 480 Washington St., Oshkosh, Wis.
LAMBERTON, Albert Meredith, M.E., '09. 114 Liberty St., New York, N. Y.
LAMONT, Clarence Booth, '00. Consulting Engineer. (1) and (3) 1414 E. Roy St., Seattle, Wash. (2) 1205-1206 Hoge Bldg., Seattle, Wash. A. S. C. E., A. S. M. E., P. N. W. S. E.
LAMSON, Warren Atherton, '04. 145 W. Jackson Blvd., Chicago, Ill.
LAND, Frank, M.E., '91. (2) and (3) Remington Arms and Amm. Co., Ilion, N. Y. (1) 513 Turtle St., Syracuse, N. Y. A. S. M. E., A. I. E. E.
LANDER, Raymond A., M.E., '12. (2) and (3) Industrial Engr., Consumers Power Co., Saginaw, Mich. (1) 90 York St., Rochester, N. Y.
LANDON, Charles Howard, M.E., '16. Experimental Engineer. (1) and (3) 1039 Massachusetts Ave., Cambridge, Mass. (2) Spray Engineering Co., 93 Federal St., Boston, Mass. S. A. E.
LANDERS, Eugene, M.E., '05. Patent Office, Washington, D. C.
LANDIS, Mark Homer, '08. (2) and (3) Gen. Mgr. and Supt., Landis Engrg. and Mfg. Co., Waynesboro, Pa. (1) 22 W. 3 St., Waynesboro, Pa.
LANDIS, Harry L., M.E., '08. 120 E. 3d St., Waynesboro, Pa.
LANDMESSER, William Robert, M.E., '17. Care H. E. Eberhardt, Maplewood, N. J.
LANDT, James Lefferts, M.E., '14. Valatie, N. Y.
LANG, Carl Everett, '99. 635 Main St., Wheeling, W. Va.
LANG, Sidney Harold, '15. 2274 7th Ave., New York, N. Y.
LANG, Howard Adam, '15. (1) and (3) 1108 11th St., Greeley, Col. (2) Great Western Sugar Co., Greeley, Col.
LANGE, Gustave, jr., '99. Address unknown.
LANE, Albert Alanson, '01. 1331 Ohio Ave., Youngstown, O.
LANE, J. Barton, M.E., '11. Asst. Mgr. Central Station. (2) and (3) Oneonta Light & Power Co., Oneonta, N. Y. (1) 46 Center St., Oneonta, N. Y.
LANE, Le Roy Clarence, M.E., '12. 342 Macon St., Brooklyn, N. Y.
LANE, Richard Jenkins, '04. 836 Huey St., McKeesport, Pa.
LANGE, Carl William, M.E., '05. 945 Spaight St., Madison Wis.
LANGE, Edward Henry, '12. (2) and (3) Physicist to Carnegie Inst., Boston, Mass. (1) 1132 Mass. Ave., Cambridge, Mass.
LANGFELD, Clarence Meyer, '06. 1035 Monadnock Bldg., Chicago, Ill. A. I. E. E.
LANGSDORF, Alexander S., M.M.E., '01. Prof Elec. Eng., Dean Schools Engrg. & Arch. (2) and (3) Washington University, St., Louis, Mo. (1) 1205 Amherst Pl., St. Louis, Mo. Fellow A. I. E. E.
LANGSTON, Samuel Macdonald, '02. President. (2) and (3) Samuel M. Langston Co., Camden, N. J. (1) Wenonah, N. J.
LANMAN, G. B., M.E., '16. 700 Franklin Ave., Columbus, O.
LANMAN, William K., M.E., '95. Pres. Columbus Bolt Works. (2) and (3) Norwich Bldg., Columbus, O. (1) Marble Cliff, Ohio.
LANNING, Fred Budd, M.E., '12. Marksboro, N. J.
LAPE, Willard E., B.M.E., '77. Mech. Engr. (2) and (3) H. H. Franklin Mfg. Co., Syracuse, N. Y. (1) 614 S. Crouse Ave., Syracuse, N. Y. A. S. M. E.
LAPP, Grover William, M.E., '07. Marblehead, O.
LARCO Y HERRERA, Alberto Fortunato, M.E. '98. Casilla 12, Chiquitoy, Trujillo, Peru, S. A.
LARDNER, James Francis, jr., '15. Care Walsh Construction Co., Box 36, Syracuse, N. Y.
LARSEN, Christian Jacob, '91. 150 Nassau St., New York City.
LARRABURE, '09. 25 Correo St., Lima, Peru.
LARNED, Sherwood Johnston, M.E., '90. (2) and (3) Gen. Traffic Supt. Chicago Telephone Co., Chicago, Ill. (1) 212 W. Washington St., Chicago, Ill.
LARNED, William Augustus, '94. Summit, N. J.
LARSON, Archie Milton, M.E., '04. Willmar, Minn.
LARZELERE, Charles Benham, M.E., '97. Switchboard Designer. (2) General Elec. Co., Schenectady, N. Y. (1) and (3) 45 Parkwood Blvd., Schenectady, N. Y. Sigma Xi, A. I. E. E.
LASHER, Ramsdell Stanton, M.E., '14. 418 Hamilton St., Evanston, Ill.
LASK, Frederick, M.E., '04. Catalogue Editor, Am. Soc. of Mech. Engrs. (1) and (3) 1033 Boston Road, New York City. (2) 29 W. 39th St., New York City. A. S. M. E.
LATHAM, Charles, jr., '04. 947 N. Meridan St., Indianapolis, Ind.
LATHROP, L. H., M.E., '15. Pike, N. Y.
LATIMER, Homer H., M.E., '09. St. Raymonds, Quebec, Can.
LATIMER, Thomas Henry, '13. Saratoga Springs, N. Y.
LATZ, Robert Columbus, '15. (2) and (3) Care Robbins Conveying Belt Co., 13 Park Row, New York City. (1) 17 Werner Ave., Tompkinsville, N. Y.
LAUDERDALE, Charles A., M.E., '02. 225 Rivers Rd., Niagara Falls, Ont., Can.
LAUDMERSER, W. R., M.E., '16. Mountain View Terrace, Maplewood, N. J.
LAURIE, William David, '15. Schenectady, N. Y.
LAUTZ, Carl Francis, M.E., '17. 54 Crescent Ave., Buffalo, N. Y. Tau Beta Pi.
LAUTZ, Edward George, '15. 54 Crescent Ave., Buffalo, N. Y.
LAUTZ, Theodore Van Vleck, M.E., '17. 614 W. Ferry St., Buffalo, N. Y.
LAUTZ, Walter Leonard, M.E., '12. 54 Crescent Ave., Buffalo, N. Y.
De LAVAL, Rudolf Patrick, '13. 136 Highland Ave., Orange, N. J.
LAW, Joseph Edward, '11. Address unknown.
LAW, Lito Willet, M.E., '05. Collins, N. Y.
LAW, Stanley Overholt, M.E., '17. 325 Graham St., Pittsburg, Pa.
LAWLER, Sturgis Samuel, M.E., '14. 1004 Summit St., Minneapolis, Minn.
LAWRENCE, John Henry, M.E., '09. 13 Ash Grove Pl., Albany, N. Y.
LAWRENCE, Norman Spear, M.E., '05. Care Whiting Foundry Equip. Co. Harvey, Ill.
LAWSON, George, M.E., '06. Superior of Employment & Instruction, N. Y. State Railways. (2) 267 State St., Rochester, N. Y. (1) and (3) 542 Blossom Rd., Rochester, N. Y. A. I. E. E., A. E. R. A.
LAY, Robert Phinny, M.E., '07. 2008 Grand Blvd., West, Detroit, Mich.
LAYTON, George Monroe, '02. Chief Engr. (2) Montour Steel Co., Montour Falls, N. Y. (1) and (3) Montour Falls, N. Y.
LEA, Robert Brooke, '15. Camillus, N. Y.
LEAR, John Emery, '05. Instructor, College Station, Texas.
LEAVERTON, Alfred Clifton, M.E., '96. Marine Engr. (2) Staten Island Shipbuilding Co., Port Richmond, N. Y. (1) and (3) 92 Jewitt Ave., Port Richmond, N. Y.
LEAVERTON, Richard Cordray, '08. Chestertown, Md.
LEAVITT, Arthur Harter, M.E., '09. 72 Everett Ave., Akron, O.
LECKIE, William Murray, '95. Joplin, Mo.
LE CONTE, Joseph Nisbet, M.M.E., '92. Prof. of Eng. Mechanics. (2) and (3) University of California, Berkeley, Cal. (1) 19 Hillside Court, Berkeley, Cal. A. S. M. E., Sigma Xi.
LEE, Charles Avery, jr., M.E., '06. (1) and (3) 631 Bluff St., Beloit, Wis. (2) B. C. Electric Railway Co., Vancouver, B. C. A. S. C. E., C. S.C.E.
LEE, Cazenove Gardner, jr., M.E., '07. (2) and (3) E. I. du Pont & Co., City Point, Va. (1) City Point, Va. A. I. E. E.
LEE, Frank Walton, M.E., '15. Salesman. (2) and (3) care Ingersoll Rand Drill Co., Phillipsburg, N. J. (1) St. Louis, Mo.
LEE, Harold, M.E., '97. 22 Colman Block, Seattle, Wash.
LEE, John McClellan, M.E., '03. 72 W. Adams St., Chicago, Ill.
LEE, Myron A., M.E., '09, M.M.E., '13. Asst. Prof. Machine Design. (2) and(3) Sibley College, Cornell, Ithaca, N. Y. (1) 130 Linden Ave., Ithaca, N. Y. Sigma Xi.
LEE, Maurice du Pont, M.E.,'08. 1075 Jefferson St., N. W. Washington, D. C.
LEE, Walter Edward, M.E., '11. Water Engineer. (2) City of Baltimore, Md. (1) and (3) 1801 Bolton St., Baltimore, Md.
LEE, Warren Kohthaas, M.E., '14. 354 Main St., Brockport, N. Y.
LEEPER, James Luther, jr., '09. Address unknown.
LEETCH, William Dougal, '15. 3259 R. St., Washington, D. C.
LEFEBVRE, Emile Joseph, '05. E. Baton Rouge Co., Manchac, La.
LEFENS, Walter Conrad, M.E., '06. (1) 2626 Michigan Ave., Chicago, Ill. (2) and (3) 179 W. Washington St., Chicago, Ill.
LEFEVRE, Cornelius Du Bois, M.E., '11. Highland, N. Y. 15 Dey St., New York City.
LEFFERTS, Edwin Boughton, M.E., '07. Ry. Engineer. (2) and (3) 1217 Equitable Bldg., New York City. (1) 1741 W. 11th St., Brooklyn. A. I. E. E.
LEFFLER, Leo Julius, M.E., '07. Sec. Chas. Leffler & Co. (2) and (3) 49-73 Clymer St., Brooklyn, N. Y. (1) 365 Benedict Ave., Woodhaven, N. Y. A. S. M. E.
LEGG, William Fairfax, M.E., '94. 314 Seaton Pl., N. E., Washington, D. C.
LEHMAN, George Robert, M.E., '09. 125 Carroll Ave., Tacoma Park, D. C.
LEHMAN, Myron Greentree, M.E., '10. Sales Manager and Asst. Sec. (2) and (3) The Manufacturers' Outlet Co., Buffalo, N. Y. (1) 223 Elmwood Ave., Buffalo, N. Y.
LEIDY, Merrill Holby, M.E., '12. Gibbs & Hill, Engr. 3330 Lancaster Ave., Philadelphia, Pa.
LEIGHTON, Frederick, M.E., '05. Instructor in Physics. (3) Germantown High School, Philadelphia, Pa. (2) 501 Allston Rd., Brookline. (1) R. F. D. 3, Newtown Square, Pa.
LEIGHTON, Herbert Jackson, '81. Mfgr., 901 W. Fayette St., Syracuse, N. Y.
LEIGHTON, Kilburn, M.E., '17. 325 Holland St., Syracuse, N. Y.
LEINROTH, Jean Paul, M.E., '12. 5608 Angora Ave., Philadelphia, Pa.
LEISER, Roy, '00. Factory Manager. East Seattle, Wash.
LEITE, Francisco Eusebiode Aquino, M.E., '94. Ilhas Minas, Brazil.
Le LOUP, Omer, '02. Address unknown.
LEMLER, Julius Aaron, '10. Address unknown.
de LEMOINE, Luis Fanor, jr., '07. Address not known.
LENNOX, Luther Willis, M.E., '08. 1339 N. Nevada Ave., Colorado Spr., Colo.
de LEON, Lionel Henriquez, '05. Staten Island, Shipbuilding Co. Port Richmond, N. Y.
LEON, Ricardo, '04. 11 Finoco y Palacios, Oaxaca, Mex.
LEONARD, George Russell, M.E., '17. Roseland, N. J.
LEONARD, Ralph Emerson, M.E., '09. 683 Sherburne Ave., St. Paul, Minn.
LEONARD, Stephen Rose, M.E., '95. Kenwood, N. Y.
LESLEY, Everett Parker, M.M.E., '05. Stanford Univ., Palo Alto, Cal.
LESLIE, Graham McKay, M.E., '13. 807 Newport Ave., Lakeview Sta., Chicago, Ill.
LESSELS, Clarence, M.E., '02. 7 Marshall St., Troy, N. Y.
LESTER, Robert Gaylord, '13. Box 363, Kenilworth, Ill.
LESTER, William Junius, M.E., '96. 2201 Greenwood St., Pueblo, Col.
LEVENTRY, Roy L., '11. Cambria Steel Co., Johnstown, Pa.
LEVINE, Louis, M.E., '12. Majestic Hotel, S. Bethlehem, Pa.

LEVY, ARTHUR BERNARD, M.M.E., '90. 11A W. 94 St., New York City.

LEVY, BERNIE MEYER, '05. Address unknown.

LEVY, LEHMAN, M.E., '91. 47th St. and 1st Ave., New York City.

LEVY, MARCEL SAMUEL, M.E., '09. 81 Ave. De Malakoff, Paris, France.

LEVY, MAX, E.E., '90. Address unknown.

LEWIS, CHAS. HENRY, M.E., '08. Asst. Div. Supt. for Public Service Elec. Co. (2) and (3) Palisade Ave. and Ferry St., Jersey City, N. J. (1) 256 Fulton Ave., Jersey City, N. J.

LEWIS, CHARLES KEELER, M.E., '12. Seneca Falls, N. Y.

LEWIS, EDWIN JAMES, C.E., '09. (1) and (3) 63 E. Bond St., Corry, Pa. (2) Supt. Climax Mfg. Co., Corry, Pa. A. S. M. E

LEWIS, FREDERICK, '06. 514 Dickinson Bldg., Norfolk, Va.

LEWIS, FREDERICK WORTHINGTON, '94. Care War Dept., Washington, D. C.

LEWIS, GEORGE HARDING, M.E., '97. 422 Dickson Bldg., Norfolk, Va.

LEWIS, GEO. W., M.M.E., '10. Asst. Prof. Mech. Eng. (2) and (3) Swarthmore College, Swarthmore, Pa. (1) 16 Princeton Ave., Swarthmore, Pa. A. S. M. E.

LEWIS, HAROLD MCLEOD, M.E., '09. Sales Engr., Switchboard Sales Dept. (2) and (3) Gen. Elec. Co., Schenectady, N. Y. (1) 235 Union St., Schenectady, N. Y.

LEWIS, HERBERT PICKERING, '99. Vice-Pres. Nat. Metal Co., 2 A Cinco de Mayo 3, Mexico City, Mexico.

LEWIS, IRVING CHAUNCEY, M.E., '99. Ulysses, Pa.

LEWIS, JOHN, B.M.E., '79. 1000 E. North Grand Ave., Springfield, Ill.

LEWIS, LESTER HOFF, M.E., '97. 30 Church St., New York, N. Y.

LEWIS, LLOYD VIRGIL, M.E., '05. 110 Lincoln Ave., Edgewood Pk., Pa.

LEWIS, ROBERT BRUCE, M.E., '05. 500 N. 12 St., Philadelphia, Pa.

LEWIS, THEODORE BUTCHER, '94. Address not known.

LEWIS, WILLIAM HENRY, '06. Care Susquehanna Coal Co., Scranton, Pa.

LEWIS, WILLIAM JOSEPH, JR., '11. (2) and (3) Care Shipley Construction & Supply Co., Brooklyn, N. Y. (1) 335 Smith St., Brooklyn, N. Y.

LEYDA, CHARLES EDGAR, M.E., '98. Address unknown.

LEX, CHARLES EDWYN, JR., M.E., '09. 225 St. Marks Sq., Philadelphia, Pa.

LIEBERKNECHT, FREDERICK WILLIAM, M.E., '11. Pierce Bldg., Brookline, Mass.

LIGGETT, HENDERSON BELL, M.E., '12. 24 N. Lewis St., Staunton, Va.

LIGHTHALL, RAYMOND JOSEPH, '05. Care Natl. Biscuit Co., Beaumont, Texas.

DE LIMA, PLINIO, '15. Vargun, Grande, Sao Paulo, Brazil.

DE LIMA, DAVID ABENUN, '96. 71 Wall St., New York, N. Y.

LIMONT, A. W., JR., M.E., '16. 210 Seeley St., Bridgeport, Conn.

LINCOLN, HOWARD ADDISON, M.E., '13. Engr. Strathmore Paper Co. (2) and (3) Woronoco, Mass. (1) 92 Maple St., Springfield, Mass. A. S. M. E.

LINDGUIST, FRANK D., '15. (1) 15 Boston Rd., New York, N. Y. (2) and (3) Saltville, Va.

LINDMAN, RAYMOND H., '05. Salesman, Detroit Lubricator Co. (2) and (3) 57 Board of Trade, Chicago, Ill. (1) 614 Laurel Ave., Wilmette, Ill. Am. Soc. of Heating and Ventilating Engrs.

LINDSAY, HENRY DOUGLAS, M.E., '10. 258 Farwell Ave., Milwaukee, Wis.

LINDSAY, PHILIP KNOWLES, M.E., '16. 712 Peoples Gas Building, Chicago, Ill.

LINDSAY, WALLACE BLUME, M.E., '08. Commercial Eng. (2) and (3) Gen. Elec. Co., Schenectady, N. Y. (1) 1 Arnold Ave., Amsterdam, N. Y.

LINDSAY, WILLIAM EDWARD, M.E., '91. 15 Tecumseh Ave., Mount Vernon, N. Y.

LINDSLEY, ADRIAN VAN SINDEREN, M.E., '09. Power Engr., Syracuse Lighting Co. (2) and (3) 335 S. Warren St., Syracuse, N. Y. (1) Skaneateles, N. Y.

LINES, STERLING CATLIN, M.E., '98. 500 E. 3d St., Los Angeles, Cal.

LINES, WILLIAM HARRY, '09. (1) 789 W. Madison St., Portland, Ore. (2) and (3) P. R. L. & P. Co., Portland, Ore.

LINK, EDGAR MARTIN, '08. 860 Louisa St., Williamsport, Pa.

LINSON, HAROLD MYRON, '99. 113 Fair St., Kingston, N. Y.

LIPPHARDT, CHARLES E., '03. Gen. Mgr., Martin's Ferry, O.

LIPPS, LLOYD HIRGER, '13. 868 Clewell St., S. Bethlehem, Pa.

LITCHKA, KARL JACOB, '09. 27 Grove St., Tonawanda, N. Y.

LITTIG, CHARLES ROSS, '08. 1010 Cathedral St., Baltimore, Md.

LITTLE, CLARENCE DUANE, M.E., '05. (1) 157 Walnut St., Montclair, N. J. (2) and (3) 80 Maiden Lane, New York City.

LITTLE, G. J., M.E., '16. R. F. D. 2, Lowman, N. Y.

LITTLEFIELD, GEORGE OLIVER, '13. Glen Field, N. Y.

LITTLETON, ALEXANDER SILLIMAN, '04. 50 N. View St., Hazleton, Pa.

LIVERMORE, CHARLES WATERMAN, '73. Asst. Engr., U. S. Navy, retired. Box 376, Pasadena, Cal.

LIVINGSTON, ROBERT K., M.E., '16. 421 Forest Ave., Avondale, Cincinnati, O. A. S. M. E.

LIVINGSTON, ROBERT R., M.E., '01. 2 Rector St., New York, N. Y.

LIX-KLETT, ERNESTO, '08. Argentine Consulate, Rio de Janeiro, Brazil.

LLOYD, EUGENE MAC DONALD, M.E., '09. (1) 46 Ft. Washington Ave., New York, N. Y. (2) and (3) 1564 Hudson Terminal Bldg., 50 Church St., New York City.

LO, YING-CHIUN, M.E., '13. 410 Union St., Schenectady, N. Y. Care Amer. Loco. Co., Schenectady, N. Y.

LO, PO YIN, '13. Unknown address.

VAN LOBEN SELS, ERNST DIEDERICK, '06. 520 Sycamore St., Oakland, Cal.

LOCKARD, ALAN THORNDYKE, M.E., '12. Suffern, N. Y.

LOCKARD, JAMES PIERCE, M.E., '09. Steam Engrg. Dept., Lackawanna Steel Co., Buffalo, N. Y. (2) and (3) 26 Church St., Plymouth, Pa. (1) 231 Norwood Ave., Buffalo, N. Y. A. S. M. E., Buffalo Eng. Soc.

LOCKE, CHARLES SEWARD, '15. 20 Vine St., Hammondsport, N. Y.

LOCKE, HAROLD FRANKLIN, '06. 107 Chestnut St., Gardner, Mass.

LOCKE, SYLVANUS DIRE, JR., '93. Vice-Pres. and Treas. (2) and (3) Locke Steel Belt Co., Bridgeport, Conn. (1) 804 Fairfield Ave., Bridgeport, Conn.

LOCKWOOD, ALAN EDWARD, M.E., '12. Mgr. Suffolk Gas Elec. Co., Suffolk, Va.

LOCKWOOD, FRANCIS HOLLISTER, '13. Underwriter's Lab. 147 N. Washington St., Chicago, Ill.

LOCKWOOD, FRANK A., M.E., '01. Supt. (2) Denver Engineering Wks., Denver, Col. (1) and (3) 1261 Monroe St., Denver, Col.

LOCKWOOD, HARRY COOPER, M.E., '12. 344 Macon St., Brooklyn, N. Y.

LOHMAN, RALPH WALDO, M.E., '01. Los Altos, Santa Clara Co., Cal.

LOCKWOOD, LLOYD D., M.E., '16. Hurley, Ulster Co., N. Y.

LOETSCHER, EMIL CHRISTIAN, M.E., '09. 33 Winona Ave., Dubuque, Ia.

LOEWENTHAL, WILLIAM HERMAN, '05. Agent, 618 Washington Ave., Evansville, Ind.

LOHR, LENOX R., M.E., '16. 759 11th St., S. E. Washington, D. C. A. S. M. E., S. A. E.

LOMBARD, JOSÉ OSWALD, '07. Address unknown.

LONEY, BOUDINOT STOCKTON, JR., M.E., '14. 1621 John Ave., Superior, Wis.

LONG, HARRY CARL, '13. 119 Lincoln Ave., Dunkirk, N. Y.

LONGACRE, FREDERICK VAN DUZER, M.E., '97. Chief Engineer. (1) 40 Graystone Park, Yonkers, N. Y. (2) and (3) Ingersoll Rand Co., 11 Broadway, New York City.

LOUGHLIN, FRANK JOSEPH, '15. Box 156, Westbury, N. Y.

LONGFIELD, LUTHER REYNOLDS, '13. Care Lewiston Bleachery & Dye Works, 80 Pine St., Lewiston, Me.

LONGMAID, H. E., M.E., '14. 531 Hemlock St., Helena, Mont.

LONGSTRETH, MORRIS, '80. Address unknown.

LONGWELL, HENRY EDGAR, B.M.E., '83. Gen. Mgr., Westinghouse Air Spring Co. (2) and (3) Smedley Bldg., 3, New Haven, Conn. (1) 129 Livingston St., New Haven, Conn. A. S. M. E., S. A. E.

LONGWELL, JAMES RUSSELL, M.E., '13. Care West High School, Des Moines, Ia.

LOOMIS, ALBERT OSBORN, M.E., '10. 343 Union Ave., Elizabeth, N. J.

LOOMIS, FREDERIC COLT, M.E., '14. 759 Main St., N. Leominster, Mass.

LOOMIS, JULIUS S., M.E., '90. Sales Agent. (2) and (3) Pekin, Ill., P. O. Box 123. (1) 304 S. Cap. St., Pekin, Ill.

LOOMIS, LEROY HOWARD, '05. 1676 Magnolia Dr., Cleveland, O.

LOOS, CHARLES LOUIS, JR., '01. Automobile Salesman. (1) Lee Hutchins Hotel, Oklahoma City, Okla. (2) and (3) White Motor Car Co., Dallas, Texas.

LOOS, GEORGE WILLIAM, '72. (1) and (3) 56 Euclid Ave., Haddonfield, N. J. (2) Bk. Oil and Naval Stores Business, 134 S. Front St., Philadelphia, Pa.

LOPEZ, CELSO, M.E., '15. 213 Ituzaingo, Salta, Arg. Republic.

LOPEZ, JOHN HILTON, M.E., '17. 80 Washington St., Newport, R. I.

LOPEZ, JOSÉ OLIVERAS, '10. Address unknown.

LOPEZ, MOSES E., JR., '99. 190 W. Peachtree St., Atlanta, Ga.

LORD, CHARLES CLIFFORD, '00. Address not known.

DE LORENZI, OTTO, '15. New York City.

LORMOR, HENRY WEBB, M.E., '13. Plant Engr., Willard Storage Battery Co., Cleveland, O. 11421 Mayfield Rd., Cleveland, O.

LOSEE, GEORGE NASH, M.E., '16. Morse Chain Works, Ithaca, N. Y. 125 Catherine St., Ithaca, N. Y.

LOUER, LEWIS STERN, '04. 842 Monadnock Blk., Chicago, Ill.

LOUGHRAN, ALEXIUS MICHAEL, '10. (1) 114 Greenway North, Forest Hills, New York City. (2) and (3) 214 Carlton Ave., Brooklyn, N. Y.

LOUGHRIDGE, CLYDE HIGBEE, M.E., '04. Loughridge Eng. Co., Pittsburg, Pa.

LOUGHRIDGE, HOWARD REID, M.E., '09. 6301 Jackson St., Pittsburg, Pa.

LOUIS, CHARLES AUSTATT, '97. 1878 East 177th St., New York City.

LOUIS, HENRY CHARLES ERNEST, M.E., '06. 2322 Callow Ave., Baltimore, Md.

LOUIS, OTTO THEODORE, MM..E., '92. 70 5th Ave., New York, N. Y.

LOVEJOY, FLOYD ARTHUR, M.E., '12. 1 Sheldon Court, Ithaca, N. Y.

LOVEJOY, HARRY OTIS, M.E., '01. 434 Potomac Ave., Buffalo, N. Y.

LOVEJOY, WM. H., '08. Supt. of Filtration, Louisville Water Co. (2) and (3) Crescent Hill Filters, Louisville, Ky. (1) 113 Hillcrest Ave., Louisville, Ky. Eng. and Arch Club, Am. Water Works Assn.

LOVELAND, DANIEL ARTHUR, M.E., '07. 521 S. Wilbur Ave., Sayre, Pa.

LOVELL, JOHN GIBBS, '00. Address not known.

LOVELL, WILLIAM WAYNE, '92. Office Mgr. (1) 58 Sympstone Ave., Lawrence Park, Toronto, Can. (2) and (3) Canadian Westinghouse Co., Toronto, Canada.

LOWE, HENRY LELAND, M.E., '03. Care Natl. Light & Power Co. 1551 Pierce Bldg., St. Louis, Mo.

LOWE, WILLIAM BELL, JR., '95.

LOWNDES, ANDREW JACKSON, M.E., '05. Sales Engineer. (1) 914 Newington Ave., Baltimore, Md. (2) and (3) 527 N. Howard St., Baltimore, Md. Sigma Xi.

LOWNSBERG, BENJAMIN FERNS, JR., '13. Piedmont Buggy Co., Monroe, N. C.

LOWRY, ARTHUR THOMPSON, '07. Traveling Salesman. (2) Keystone Lubricating Co., Pittsburgh, Pa. (1) and (3) 601 E. Third St., Berwick, Pa. Jenkins Arcade Bldg., Pittsburgh.

LUBKE, ARTHUR F., M.E., '14. Sec.-Treas. B. L. Fry, Mfg. Co. (2) and (3) 919 N. Market St., St. Louis, Mo. (1) 6339 Berlin Ave., St. Louis, Mo.

LUCE, ROBERT FRANCIS, M.E., '17. Woodhaven, L. I., N. Y.

LUCE, RICHARD SANBORN, M.E., '12. Mech. Engineer. (1) and (3) Care R. H. Luce, 5th Ave. and E. 19th St., New York City. (2) Eng. Dept. Int. Paper Co., New York City.

LUCKER, FRED L., M.E., '09. Elect. Engr., Ingersoll Rand Co. (2) and (3) 11 Broadway, New York City. (1) 1023 Carroll St., Brooklyn, N. Y.

LUCKER, GROVER, M.E., '06. 928 Rivermet Ave., Ft. Wayne, Ind.

LUDLAM, HARVEY WEEKS, M.E., '92. Oyster Bay, N. Y.

LUFKIN, HAMILTON MCCURDY, A.B., '14. Care St. Paul Fdry. Co., 617 Goodrich Ave., St. Paul, Minn.

LUHMAN, LELAND HOWE, '10. Postville, Iowa.

LUHRMAN, JOHN FREDERICK, M.E., '09. Avondale, Cincinnati, O.

LUKESH, GEORGE MARTIN, '96. Paymaster, U. S. Navy Dept., Washington, D. C. Unknown address.

LUNA, RAFAEL SOTOMAYER, '09. Nueve de Octurbe, Guayaquil, Ecuador, S. A.

LUNDGREN, WILLIAM EDWARD, M.E., '14. In charge of casualty dept. of J. A. Eckert & Co., Insurance. 55 St. John St., New York, N. Y.

LUNT, ALEXANDER DRUMMOND, E.E., '92, M.M.E., '93. Gen. Elec. Co., Schenectady, N. Y.

LUPPEN, LUPPE BARNES, '07. 2423 1st Ave., Sacramento, Cal.

LUTHER, GEORGE WILLIAM, M.E., '05. Luther Garage Co., Olean, N. Y.

LUTZ, JOHN MILTON, '13. Lubricating Engineer. Steam Engine Dept., Tenn. Coal, Iron and R. R., Ensley, Alabama. (3) 2818 Juniper Ave., Birmingham, Ala.

LYDON, JOHN COYLE, '11. Perry, Okla.

LYFORD, F. E., M.E., '16. 508 B St., Sparrows Point, Md.

LYLE, WILLIAM FRANK, '07. 121 S. 10 Ave., Mt. Vernon, N. Y.

LYMAN, JAMES, E.E., '94, M.M.E., '95. 1308 Maple Ave., Evanston, Ill.

LYNAH, JAMES, M.E., '05. Works Mgr. (2) and (3) Care E. I. du Pont de Nemours Powder Co., Haskell, N. J. (1) Haskell, N. J. Am. Ass. for Advancement of Science, A. I. E. E.

LYNAUGH, WILLIAM FRANCIS, M.E., '11. 3410 St. Paul Ave., Milwaukee, Wis.

LYNCH, JOHN COOPER, M.E., '96. Gen. Supt. of Traffic Bell Tel. Co. of Pa. (2) and (3) 1230 Arch St., Philadelphia, 'Pa. (1) The Belgravia, 18th and Chestnut Sts., Philadelphia, Pa. A. I. E. E.

LYNDON, LAMAR, '96. Engr., 60 Broadway, New York City.

LYNES, GORHAM MALTBIE, '13. 200 Hicks St., Brooklyn, N. Y.

LYNN, LAURANCE KING, M.E., '06. Gen. Elec. Co., Oliver Bldg., Pittsburgh, Pa. 637 Summerlea St., Pittsburg, Pa.

LYNN, EDISON A., M.E., '12. Care Pacific Coast Borax Co., Death Valley, Cal. (2) and (3) 311 Walnut St., Holyoke, Mass.

LYON, HENRY HOPKINS, M.E., '01. 200 Electric Bldg., Buffalo, N. Y.

LYON, MONCURE NELSON, '09. Care Jas. W. Lyon, Mt. Wilson, Md.

LYON, PERCY SHEPARDSON, M.E., '12. Meter Engineer. (1) Overlook, Pa. (2) Harrison Safety Boiler Works, Philadelphia, Pa. (3) 3146 N. 17th St., Philadelphia, Pa. A. S. M. E.

LYSTER, THOMAS LEE BRUNT, M.M.E., '03. Development & Fund Co., Niagara Falls, N. Y. Univ. Club, Niagara Falls, N. Y.

LYTLE, GEORGE ANDREW, '93. Decatur, Ill.

LYTLE, CHARLES AUGUSTUS, M.E., '96. Petroleum Iron Wks., Sharon, Pa.

LYTLE, LOUIS EDWARD, '96. Supt. West Air Brake Co., Wilmerding, Po.

LYTTON, WALKER, '08. 20 East Delaware Pl., Chicago, Ill.
McADAM, JOHN VAUGHN, M.E., '00. 417 E. 93 St., New York, N. Y.
McADOO, M. R., JR., M.E., '14. 629 W. 115 St., New York City.
McALLISTER, ADDAMS STRATTON, M.M.E., '01. Elec. and Ill. Engr. 261 West 23d St., New York City. Soc. Prom. Eng. Education, Nat. Elec. Lt. Assoc., Amer. Electrochemical Soc., Sigam Xi, Eta Kappa Nu, Tau Beta Phi.
McALLISTER, CHARLES ALBERT, M.E., '87. Revenue Cutter Serv., Washington, D. C.
McARTHUR, WARREN J., M.E., '08. McArthur Bros., Motor Cars and Trucks, Phoenix, Ariz. 30 W. Portland Pl., Phoenix ,Ariz.
McBRIDE, FRANCIS REED, M.E., '13. 487 E. 23d St., Portland, Ore.
McBRIDE, LESLIE BAILEY, M.E., '10. 2269 High St., Oakland, Cal.
McBRIER, FREDERICK BELL, M.E., '96. Ball Engine Co., Erie, Pa.
McBROOM, CASSIUS REMINGTON, M.E., '15. 720 S. Washington St., Spokane, Wash.
McBURNEY, HENRY, '02. Stockbridge, Mass.
MACGREGOR, JAMES FERGUSON, M.E., '92. Galt, Ont., Canada.
McCALL, FRANK HAMILTON, '93. Star Electric Co., Newark, N. J.
McCANN, DWIGHT GLENN, M.E., '12. Berks Co., Trust Bldg., Reading, Pa.
McCARTHY, ELMER TAYLOR, M.E., '10. (1) 5547 Dorchester Ave. (2) and (3) 72 W. Adams St., Chicago, Ill.
McCARTHY, THOMAS BERNARD, '75. Druggist, Coulterville, Cal.
McCARTY, RALPH, M.E., '96. Hamburg, N. Y.
McCHESNEY, FRANK WILLIAM, M.E., '10. Everett, Wash.
McCHESNEY, JOHN DAVID, '17. 242 Warwick St., Brooklyn, N. Y.
McCLAVE, ROBERT BROOKS, M.E., '11. Asst. Mgr. McClave-Brook Co., Scranton, Pa.
McCLAY, ANDREW HOWARD, M.E., '12. Wyoming Ave. and B St., Philadelphia, Pa.
McCLELLAN, HUGH HERBERT, M.E., '97. 28 Hawthorn Ave., Troy, N. Y.
McCLELLAN, WILLARD DOBSON, M.E., '12. Beaver River Power Co., Bliss, Idaho.
McCLENAHAN, ROY REGESTER, M.E., '05. Cambria Steel Co. (1) 1016 Linton Ave., Johnstown, Pa. (2) Cambria Steel Co., Gantier Dept. (3) 1016 Linton Ave., Johnstown, Pa.
McCLENATHEN, ROBERT, M.E., '97. 497 E. Buchtel Ave., Akron, O.
McCLINTOCK, ALLAN PATTON, M.E., '10. 421 Jarvis St., Toronto, Ont., Can.
McCOLL, GILBERT BEEBE, '06. Surveyor, 178 Langside St., Winnipeg, Mont. Canada.
McCOMB, EDWARD CHIDESTER, M.E., '88. Pres. Bridge Co., Box 783, Roanoke, Va.
McCOMB, WILLIAM NELSON, '92. The Orchard Farm, Lakewood, N. Y.
McCONAHEY, WILLIAM McCONNELL, '93. Engrg. Dept. W. E. & Mfg. Co., East Pittsburg, Pa.
McCONNELL, BENJAMIN STUART, M.E., '08. 2001 Niles Ave., St. Joseph, Mich.
McCONNELL, EDWARD DENNISON, '94. Sheffield, Ala.
McCONNELL, ELLICOTT, '98. Address not known.
McCONNELL, HAROLD MEAD, M.E., '07. Sec. and Asst. Supt., Compound Door Co. (2) and (3) St. Joseph, Mich. (1) 2001 Niles Ave., St. Joseph, Mich.
McCONNELL, ROBERT ALEXANDER, '10. 327 E. Broad St., Columbus, O.
McCORKLE, JOHN THOMAS RILEY, '04. Nampa, Idaho.
McCORMICK, BRADLEY THOMAS, M.E., '03. Allis-Chalmers Bullock Co., Montreal, Canada.
McCORMICK, FRANK HARRINGTON, M.E., '10. 402 Hawthorne Rd., Roland Park, Baltimore, Md.
McCORMICK, WILLIAM STANLEY, M.E., '17. Penrose, Col. Tau Beta Pi.
McCOOK, GEORGE WYTHE, JR., '08. Winnemucco, Nevada.
McCREARY, HARRY DEEMER, '10. R. F. D. 3, New Castle, Pa.
McCULLOH, JAMES WOODBURY, '97. 111 W. Jackson Boulevard, Chicago, Ill.
McCULLOCH, WILLIAM FREDERICK, '95. Architect. Hempstead, N. Y.
McCULLOUGH, RANDALL JOHN, '10. Chazy, N. Y.
McCUNE, JOSEPH CONDIT, '07. Mech. Expert, Eastern District W. A. B. Co., (1) 138 E. 38th St., New York City. (2) and (3) Care Westinghouse Air Brake Co., 165 Broadway, New York City. Manhattan Air Brake Club, A. S. M.E., N. Y. R. R. Club, Air Brake Assoc.
McCURDY, ALEXANDER DALES, M.E., '07. 2360 N. 13 St., Philadelphia, Pa.
McCURTAIN, ENSEL LEROY, M.E., '17. 1017 1st Ave., Salt Lake City, Utah.
McCUTCHEON, KENNETH CHARLES, M.E., '15. (2) Duquesne Plant of Carnegie Steel Co. (1) 119 Library Place, Duquesne, Pa., or Bellefield Dwellings, Centre Ave., Pittsburgh, Pa. A. S. Mining Eng.
McDERMOTT, GEORGE ROLAND, '05. Ithaca, N. Y.
McDERMOTT, MORGAN BLAND, '17. Wagner Elec. Mfg. Co. (2) First National Bank Bldg., Cincinnati, O. (1) 236 Scott St., Tucson, Ariz. A. I. E. E.
MACDONALD, ALAN, M.E., '05. MacDonald & Kahn. 905 Rialto Bldg., San Francisco, Cal.
McDONALD, ANDREW YOUNG, '91. 61 Prairie St., Dubuque, Iowa.
McDONALD, CLARENCE ALEXANDER, M.E., '96. Lahainaluna School, Hawaii. Lahaina, Moui, Hawaii.
MACDONALD, HENRY GORDON, M.E., '01. 170 Broadway, New York, N. Y.
McDONALD, HUGH FACKLER, '01. Engineer. McKinney, Texas.
McDONALD, JAMES STUART, JR., '91. 1708 Tribune Bldg., Chicago, Ill.
MACDONALD, MALCOLM SOMERLAND, '04. Address not known.
McDONALD, STEWART, M.E., '99. (1) 5305 Delaware Ave., St. Louis, Mo. (2) and (3) Pres. Moon Motor Car Co., St. Louis, Mo.
McDONELL, DUNCAN ROSS, M.E., '14. 335 Iowa Bldg., Tulsa, Okla.
McDOUGALD, GEORGE ARCHIBALD, '04. Address not known.
McDOUGALL, ERIC WALTER, M.E., '06. 106 Claremont Ave., Montclair, N. J.
McDOUGALL, JOHN, '80. Hornell, N. Y.
McELROY, ROBERT CHRISTIAN, M.E., '12. Box 476, Erie, Pa.
McEWEN, KENETH BUTTS, '94. Barnards, N. Y.
McEWAN, THOMAS SPRING, M.E., '11. Dept. Sales Engr., S. K. E. Ball Bearing Co. (2) and (3) Highland Court Hotel, Hartford, Conn. (1) 421 High St., W. Hoboken, N. J. A. S. M. E. (Junior).
McFADDEN, BENJAMIN CURTIS, M.E., '08. 726 N. Genesee St., Waukegan Ill.
McFADDIN, HARRISON D., M.E., '94. Merchant. (2) 38 Warren St., New York City. (1) and (3) 137 Harrison St., East Orange, N. J.
McFARLAN, EDWARD, M.E., '08. 360 Jefferson Ave., Brooklyn, N. Y.
MACFARLAND, HELEN BROOKS, M.M.E., '03. Engineer Tests, Santa Fe Ry. Co. (2) 914 Railway Exchange, Chicago, Ill. (1) 5758 Kenwood Ave., Chicago, Ill. A. S. M. E., A. R. E. A., I. R. F. A., R. M. M. A., M. C. B. Assoc.
MACFARLANE, ALFRED DART, '02. La Follette, Tenn.
MACFARLANE, JAMES WILLIAM, JR., '07. 7137 Penn. Ave., Pittsburgh, Pa.
McGEE, WALTER VAUGHN, '07. Address not known.
McGINTY, JOHN THOMAS, M.E., '03. 43 Paine St., Green Island, N. Y.
McGLONE, JOHN, M.E., '06. (1) 613 N. Calhoun St., Baltimore, Md. (2) 15 Dey St., New York City.
McGOWN, WILSON ELIAS, '04. Hardware Merchant. (1) 49 Elm St. (2) Main St., Cooperstown, N. Y.
McGRAW, DONALD, M.E., '13. Grosse Pointe Farms, Mich.
McGUINNESS, W. V., M.E., '16. 195 Broadway, New York City.
McHOSE, HOWARD HORMISH, M.E., '13. Castasauqua, Pa.
McHOSE, MALCOLM MONROVE, M.E., '14. Box 286, Castasauqua, Pa.
McILVAINE, JOHN HARMON, M.E., '14. 40 Claverly Hall, Cambridge, Mass.
McINTIRE, THOMAS BROWN, '11. 350 Atlantic Ave., Pittsburg, Pa.
McINTOSH, ROBERT, M.E., '05. Asst. Supt. Calumet & Hecla Mining Co. (2) C. & H. Mining Co., Lake Linden, Mich. (1) and (3) 572 Elm St., Calumet, Mich. A. S. M. E., A. I. E. E.
McINTYRE, EUSTACE TEMPLE, '04. Address not known.
McINTYRE, WILLIAM HOWELL, JR., '11. 259 Seventh Ave., Salt Lake City, Utah.
McIVER, GEORGE WALTER, M.E., '06. 51 Legare St., Charleston, S. C.
McKAY, ANDREW WILLIAM, B.S. in Agr. '08. C. Shrader Co. Orlando Fla.
McKAY, CHARLES WATSON, M.E., '06. Assistant Engr., McMean & Miller Cons. Engrs. (2) and (3) 1454 Monadnock Block, Chicago, Ill. (1) 461 Washington Ave., Brooklyn, N. Y. Chicago Engineers Club.
McKAY, MAURICE PARKER, M.E., '01. 10 Bridge St., New York City.
McKEE, J. B., M.E., '14. Apt. 17, Kenilworth, Buffalo, N. Y.
McKEE, ROBERT A., M.M.E., '97. 2311 Grand Ave., Milwaukee, Wis.
McKENDRICK, LESLIE, M.E., '12. Singer Tower, New York City.
MACKEY, FLOYD SHERMAN, '10. Gilboa, N. Y.
McKIBBIN, FREDERICK WILLIAM JAMES, M.E., '98. Troy, N. Y.
McKINLEY, CHARLES WESLEY, '11. 401 Victoria Place, Toledo, O.
McKINNEY, ROBERT COCHRAN, '76. 111 Broadway, New York City.
McKINNEY, WILLIAM PERCY, M.E., '15. Care Marion Steam Shovel Co., Marion, Ohio.
McKISSICK, ANTHONY FOSTER, M.M.E., '95. Grendil Mills, Greenwood, S. C.
McKITTRICK, FREDERICK JAMES ALEXANDER, '98. Kentville, Nova Scotia, Canada.
McKNEW, RICHARD TAYLOR, M.E., '10. 5413 Black St., E. Liberty, Pa.
McKOWN, REID WILLIAM, M.E., '07. Mechanical Efficiency Eng., Pitts. Plate Glass Co. (1) 5908 Douglas Ave., Pittsburgh, Pa. (2) and (3) 1456 Frick Annex, Pittsburgh, Pa.
McLAREN, WILLIAM FREDERICK, M.E., '94. 3 Ravens Cliff Ave., Hamilton, Ont., Can.
McLAUGHLIN, CORNELIUS DENIS, M.E., '12. 1005 Geddes St., Syracuse, N. Y.
McLAUGHLIN, THEODORE SMITH, '92. 816 Security Bank Bldg., Minneapolis, Minn.
McLAURY, WALKER GAILEY, '07. Natl. City Bank of Chicago, Chicago, Ill.
McLEAN, JOSEPH PATTON, '98. 88 Highland Ave., Jersey City, N. J.
McLEARY, SAMUEL HARVEY, M.E., '04. Fort Washington, Md.
McMASTER, FRANK, '92. The Suburban Gas & Electric Co. (1) 112 McDonough St., Decatur, Ga. (2) 22 Sycamore St., Decatur, Ga.
McMASTER, M. D., M.E., '16. 72 Adams St., Akron, O.
McMEEKEN, DAVID, JR., M.E., '03. 1263 Eastern Parkway, Brooklyn, N. Y.
McMICKEN, MAURICE REY, M.E., '14. L.L.B., '17 (2) 660 Coleman Bldg., Seattle, Wash. (1) 1630 16th Ave., Seattle, Wash.
McMILLAN, HUGH GURNEY, M.E., '07. 243 Riverside Ave., Yonkers, N. Y.
McMURRAY, T. L., M.E., '14. 531 E. Church St., Marion, O.
McMILLAN, ROBERT DUDLEY, M.E., '10. East Aurora, N. Y.
McMYNN, JOHN CLARKE, M.E., '91, M.M.E., '92. (1) 948 Sheridan Bd., Lake View Sta., Chicago, Ill. (2) and (3) 4727 Prairie Ave., Chicago, Ill.
McNAIRY, ALMOS B., B.M.E., '77. Mfgr. and Banker. (2) and (3) 404 Hickox Bldg., Cleveland, O. (1) 3333 Euclid Ave., Cleveland, Ohio. A. S. M. E.
McNAUGHTON, EDGAR, M.E., '11. Asst. Prof. in M.E., Tufts College. (1) (2) and (3) 88 Quincy St., Tufts College, Mass. A. S. M. E., S. P. E. E., Tau Beta Pi.
McNEAR, GEORGE PLUMMER, JR., M.E., '13. Stag Club, R. F. D, Penn's Grove, N. J.
McNIDER, STANLEY CORWINE, M.E., '93. 70-3 Ave. S., Guatemala, C. A.
McNITT, ROBERT J., M.E., '04. Asst. Vice-Pres., R. & H. Chem. Co. (2) Roessler & Hasslacher Chem. Co., Perth Amboy, N. J. (1) and (3) 1 Lewis St., Perth Amboy, N. J. A. I. E. E.
McPHERSON, HENRY HUME, M.E., '03. 214 Masonic Temple, Denver, Colo.
McPHERSON, J. W., '16. Haw River, N. C.
MACPHERSON, LESLIE MITCHELL, M.E., '07. Parka Balranold, N. S. W. Australia.
McRAE, FRANK G., M.E., '02. Supt. of Power, Adirondack Elec. Power Corp. (2) and (3) Glens Falls, N. Y. (1) 17 Flandreaux Ave., Glens Falls, N. Y. A. I. E. E., N. A. L. A.
McVETTY, PERCY GEORGE, M.E., '13. Instructor, Engrg. Research. (2) and (3) Sibley College, Ithaca, N. Y. (1) 708 E. Seneca St., Ithaca, N. Y.
McWHINNEY, RAY STEWART, '14. Care Hutchison & Penna, Edgewood, Pa.
McWHORTER, HUGH BROOKS, M.E., '08. 422 N. Cayuga St., Ithaca, N. Y.
MABEY, ARTHUR ROE, M.E., '99. Foreman, Thermometer Dept. (2) Bristol Co., Waterbury, Conn. (1) and (3) 22 Farnham Ave., Waterbury, Conn. A. S. M. E.
MACEO, ANTONIO, '06. Care Thomas E. Palina, Havana, Cuba.
MACINTOSH, DONALD CHASE, M.E., '07. 1913 Northampton St., Holyoke, Mass.
MACK, ALEXANDER WOLFGANG, '90. Somerville, N. J.
MACK, EDWARD CAREY, LL.B., '14. 449 S. Madison St., Carthage, Ill.
MACK, GEORGE WILLIAM, '80. Elliston, Mont.
MACK, JOHN GIVIAN DAVIS, M.E., '88. Prof. Mach. Design, Engineering Bldg. (1) 123 W. Gilman St., Madison Wis. (2) and (3) Madison, Wis.
MACK, WILLIAM GORDON, M.E., '93. Lighting Plant, Jefferson, Wis.
MACKENZIE, RODERICK KENETH, M.E., '14. Bernardsville, N. J.
MACLACHLAN, ALAN, '14. Address not known.
MAC LAREN, MALCOLM NEILL, '91. 120 Broadway, New York City.
MACLAY, JOHN ALVAN, M.E., '15. (3) and (2) Care Newport News Shipbuilding & Dry Dock Co. (1) care Y. M. C. A., Newport News, Va.
MACLEOD, NONWOOD, '10. With Canadian Artillery.
MAC LEOD, NORMAN M., M.E., '07. Lab. Engr. Elect. Lab., Western Elec. Co. (2) 463 West St., New York City. (1) and (3) 19 Dodd St., East Orange, N. J. Cornell Club, Cosmopolitan Club.
MACNOE, GEORGE, M.E., '13. Dansville, N. Y.
MACOMBER, GEORGE STANLEY, M.E., '00. Address not known.
MACOMBER, IRVING EMERSON, M.E., '94. Real Estate Investments. (2) and (3) 223 Nicholas Bldg., Toledo, Ohio. (1) 22 Lincoln Apartments, Toledo, O.
MACOMBER, IRWIN JOHN, M.E., '88. R. F. D. 4, Ithaca, N. Y.
MACON, WILLIAM W., M.E., '98. Engrg. Editor, *Iron Age*. (2) and (3) 239 W. 39th St., New York City. (1) 711 Ave J., Brooklyn, N. Y.
MAC VICAR, DONALD GEORGE, '15. 20 Lloyd Rd., Montclair, N. J.
MACY, GEORGE E., M.E., '07. Electrical Dealer. (2) and (3) 7467 S. Shore Ave., Chicago, Ill. (1) 2453 E. 74th St., Chicago, Ill.
MACY, NELSON, M.E., '94. 441 Pearl St., New York, N. Y.

MADDEN, Bert Long, '08. Designer, Cyclemotor Corporation, Arlington Bldg., Rochester, N. Y.
MADDEN, John Henry, M.E., '07. Sec.-Treas. and Mgr., Sherwood Mfg. Co. (2) and (3) 1710 Elmwood Ave., Buffalo, N. Y. (1) 157 Highland Ave., Buffalo, N. Y.
MADDOCKS, William, '88. 2311 Crawford Ave., Parsons, Kan.
MADDREN, James, '72. 1430 50 St., Brooklyn, N. Y.
MAENAK, Warren, M.E., '16. (1) Camden Forge Co., Camden, N. J. (3) 723 Grant Ave., Collingswood, N. J.
MAGINNIS, Edward Arthur, M.E., '03. 538 Diversey Blvd., Chicago, Ill.
MAGNA, Joseph Nicholas, M.E., '06. Treas. Magna Auto Co. (2) and (3) Cor. Division & Railroad Sts., Holyoke, Mass. (1) 188 Madison Ave., Holyoke, Mass.
MAGNUS, Edward, '10. 4601 Michigan Ave., Chicago, Ill.
MAGOFFIN, Charles Frederick, M.E., '07. Care University Club, Buffalo, N. Y.
MAGONIGLE, Percy Bertram, '94. Address not known.
MAGOUN, John Warren, M.E., '12. Testing Dept., Penna. Steel Co. (2) Penn. Steel Co., Steelton, Pa. (1) and (3) 323 Pine St., Steelton, Pa. Engineers Soc. of Penn.
MAGUIRE, Jeremiah H., M.E., '98. Pres. Maguire Rubber Co. (2) and (3) 30 Church St., New York City. (1) Sands Point, Long Island. A. S. M. E.
MAHL, Frederick William, Sp. M.E., '89. Address not known.
MAHAN, James Francis, '95. Address not known.
MAIN, Eugene Adams, M.E., '07. 215 84 St., Brooklyn, N. Y.
MAINWARING, William Hamer, M.E., '05. 67 Marion Pl., Forty Fort, Pa.
MAJOR, Charles Curtiss, M.E., '98. Iowa State College, Ames, Ia.
MAKELY, Metrah, jr., '07. Edenton, N. C.
MALBY, Seth Grant, M.E., '10. 90 John St., New York, N. Y.
MALLAN, Newman Blaine, '15. Attorney and Counsellor at Law. (1) 820 Connecticut Ave., Washington, D. C. (2) Wilkins Bldg., Washington, D. C.
MALLERY, Harold Lay, M.E., '15. Care Owego Bridge Co., Owego, N. Y.
MALLERY, Lewis E., M.E., '08. (1) Cullman, Ala. (2) and (3) 413 W. State St., Olean, N. Y.
MALLORY, Henry Reed, M.E., '15. Burcalo Mfg. Co., Buffalo, N. Y.
MALLOCK, Francis Gibson, '11. Railway Signal Co. Lachine, P. Q., Canada.
MALLOUF, Nasseem, '06. Address not known.
MALONE, Allen Latta, '06. 218 W. Madison Ave., Baltimore, Md.
MALONE, Erwin Lionel, M.E., '17. 334 E. 17th St., New York City.
MALVERN, Lewis Keith, M.E., '94. Box 72, Elgin, Ill.
MANLY, Charles Matthews, M.E., '98. 17 Battery Pl., New York, N. Y.
MANN, David Farquhar, M.E., '07. Representative Pittsburgh Steel Co. (1) (2) and (3) The Cairo Apartments, Norfolk, Va.
MANN, Edward Cox, '99. 37 Allen St., Buffalo, N. Y.
MANN, Harvey Blaine, M.E., '08. Sales Engr. 1103 Diamond Bank Bldg., Pittsburgh, Pa. A. S. M. E., Eng. Soc. of Western Pa.
MANN, Robert Bruce, M.E., '05. 297 35th St., Milwaukee, Wis.
MANN, Stuart Ridell, '99. Derby, N. Y.
MANN, Veryl Edward, M.E., '13. 129 Newkirk St., Jersey City, N. J.
MANN, William Lowry, M.E., '03. York Haven, Pa.
MANNING, William Sheppard, jr., M.E., '05. (1) 150 Orchard Rd., Solvay, N. Y. (2) and (3) Solvay Process Co., Syracuse, N. Y.
MANNOCCIR, James Earle, M.E., '08. Address not known.
MANNY, Edmund Wiggins, '77. Address not known.
MANNY, Walter Roy, '13. Burroughs Adding Machine Co., Sales Agt. (2) Myrick Bldg., Springfield, Mass. (1) 169 Maple St., Springfield, Mass.
MANVILLE, William Willett, M.E., '06. 3401 West Ave., Newport News, Va.
MARBLE, Harry Mills, M.E., '93. 141 Broadway, New York, N. Y.
MARCELLUS, Roy Clark, '08. 25 Arnold Pl., N. Adams, Mass.
MARCUS, Clarence, '10. 830 Glenwood St., Cincinnati, O.
MARGERUM, Britton Albert, M.E., '06. 9514 Bustleton Ave., Philadelphia, Pa.
MARIANO, Ramon, M.E., '11. 6 Piedad St., Manila, P. I.
MARKS, Hyman Sanford, M.E., '07. 190 7th Ave., Upper Troy, N. Y.
MARKS, Lionel Simeon, M.M.E., '94. Prof. of Mech. Eng. (2) Mass. Institute of Technology. (1) 192 Brattle St., Cambridge, Mass. A. S. M. E.
MARKS, Louis Benedict, M.E., '89, M.M.E., '90. 103 Park Ave., New York, N. Y.
MARLAND, William Henry, '01. Treas. and Mgr. Reading Rubber Mfg. Co. (2) Reading, Mass. (1) 459 Chestnut Hill Ave., Brookline, Mass.
MARSH, Chas. Mercer, M.E., '03. District Manager. (2) Potomac Elec. Power Co., Washington, D. C. (1) 11 W. Irving St., Chevy Chase, Md. (3) 14th and C. Sts., Washington, D. C.
MARSH, Edgar Clark, '08. 146 Stiles St., Elizabeth, N. J.
MARSH, Robert, jr., '07. Address not known.
MARSHALL, James Wallace, M.E., '08. (1) 828 Greenridge St., Scranton, Pa. (2) and (3) 168 N. Craig St., Pittsburgh, Pa.
MARSHALL, William, M.E., '11. Grand Mere, P. Q., Canada.
MARSHALL, Willard Beverly, '98. Address not known.
MARSTON, Otis Reed, M.E., '17, B.S. 1500 Arch St., Berkeley, Cal. Eta Kappa Nu, Tau Beta Pi, A. I. E. E.
MARTIN, Francis Dalton, M.E., '15. (1) 80 McMaster St., Owego, N. Y. (2) and (3) 942 Niagara St., Niagara Falls, N. Y.
MARTIN, Frank, M.E., '00. Asst. Supt., The Celluloid Co., Newark, N. J.
MARTIN, Henry Joseph, '11. 167 Depew St., Peekskill, N. Y.
MARTIN, James William Herman, M.E., '17. 544 E. Chestnut St., Coatsville, Pa.
MARTIN, Mack, M.E., '02. Fayetteville, Ark.
MARTIN, Stuart Thompson, '13. Optometrist, Mgr. Brooklyn Off. A. Martin Inc. (2) and (3) 56 Flatbush Ave., Brooklyn, N. Y. (1) 3817 Ave I, Brooklyn, N. Y.
MARTINEZ, Carlos Alfonso, M.E., '05. Address not known.
MARTINEZ, Claudio Juan, '01. Hornos, Coahuila, Mex.
MARTINDELL, Frank, M.E., '14. 64 Morningside Ave., Waterbury, Conn.
MARTINEX, Carlos, '09. 18 Mercaderes, Areguipa, Peru.
MARVIN, John Reginald, '02. 128 Essex St., Care Diehl Mfg. Co., Boston, Mass.
MARX, August, M.E., '03. G. A. Gray Co., Cincinnati, O.
MARX, Guido Hugho, M.E., '93. Leland Stanford Univ., Stanford Univ., Palo Alto, Cal.
MARX, Henry, B.M.E., '79. Gest & Depot Sts., Cincinnati, O.
MARXNACH, Jeopilo, '06. 42 Cruz St., San Juan, P. R.
MASHEK, George Milek, '91. Escanaba, Mich.
MASON, Allen, M.E., '04. Works Manager. (2) American La France Fire Engine Co. (1) and (3) 117 Walnut St., Elmira, N. Y.
MASON, Arthur John, jr., M.E., '10. 5715 Woodlawn Ave., Chicago, Ill.
MASON, Carlisle, jr., '89. Address not known.
MASON, Charles Winder, jr., '05. Fort Porter, Buffalo, N. Y.
MASON, Daniel A., M.E., '94. Supt. of Buildings, *New York Tribune.* (2) 154 Nassau St., New York City. (1) and (3) 372 Stuyvesant Ave., Brooklyn, N. Y. A. S. M. E.
MASON, Edward Fraser, M.E., '05. 124 N. Barry St., Olean, N. Y.
MASON, Eugene George, M.E., '94. Wash. Loan & Trust Bldg., Washington, D. C.
MASON, Harry Mills, jr., M.E., '08. Care Eppinger & Russell Co. 165 Broadway, New York, N. Y.
MASON, Norman Clifford, A.B., '09. Care Amer. Express Co., rue Scribe, Paris, France, Europe.
MASON, William Horatio, '00. Supt. Edison Portland Cement Co., Stewartsville, N. J.
MASON, William Henry, M.E., '07. Sydney Tech. School, Sydney, N. S. W. Australia.
MASSEY, Walter G., M.E., '01. Factory Engr. (2) Fort Wayne Electric Works, Fort Wayne, Ind. (1) and (3) 912 Wildwood Ave., Fort Wayne, Ind.
MASSEY, John Rice, '93. (1) Cleveland Ath. Club, Cleveland, Ohio. (3) Box 387, Nela Park, Cleveland, O.
MASSIE, James Hughs, M.E., '01. 40 Fleet St., London, England.
MASTERS, Frank Milton, '08. Consulting Engineer. (1) and (3) 9 N. Front St., Harrisburg, Pa. (2) 204 Locust St., Harrisburg, Pa. Eng. Soc. of Penn., Am. Soc. Test Materials, M. A. Soc C. E.
MASTERS, Frank Wynne, '05. 2 Milan Flats, Houston, Texas.
MASTERSON, Wilmer D., M.E., '06. City Supt. of Electricity, Water Wks. and Elec. Light Plant, Galveston, Texas. (2) 1601 31st St., Galveston, Texas. (1) and (3) 30th and Ave. H., Galveston, Texas. A. I. E. E.
MASTIN, Francis Wells, M.E., '01. Address not known.
MATCHNEER, William Wade, M.E., '10. 414 Atlantic Ave., Pittsburg Pa.
MATLOCK, Robert Cutter, sr., '94. Equipment Construction. Chicago Tel. Co., Chicago, Ill.
MATSON, John Jamieson, M.E., '15. Consulting Engrg. Dept. G. E. Co. (1) and (3) 1003 Nott St., Schenectady, N. Y. (2) Consulting Eng. Dep G. E. Co., Schenectady, N. Y. A. S. M. E., A. I. E. E.
MATTHAI, Albert Dilworth, M.E., '10. Natl. Enamelling and Stamping Co., Baltimore, Md.
MATTHAI, Joseph Fleming, M.E., '12. Treas. Beaver Dam Marble Co. Cockeysville, Md.
MATTHEWS, Hubert Willard, M.E., '06. Blackville, S. C.
MATTHEWS, James Evart, M.E., '17. 115 Fennimore St., Brooklyn, N. Y.
MATTHEWS, Peter Baldy, '82. Care N. Y. Athletic Club, New York City.
MATTHEWS, Robertson, M.E., '07. Asst. Prof. Heat Power Engrg. (2) West Sibley, Cornell Univ., Ithaca, N. Y. (1) and (3) 617 N. Cayuga St., Ithaca, N. Y. S. P. E. E.
MATTHIES, William Hugo, '02. Engr. Salzufer 7, Charlottenburg, Germany.
MATTHIESSEN, Frank, '95. Vice-Pres. Columbia Tool Steel Co. (1) 4545 Drexel Boul., Chicago, Ill. (2) and (3) 528-72 W. Adams St., Chicago, Ill.
MATTISON, Albert Sherman, '07. 623 Woodrow Ave., Detroit, Mich.
MATTOX, Robert Wesley, '95. Vice-Pres. Naval Stores Steamboat Co., Jacksonville, Fla.
MATTY, Frank Joseph, '09. Parremond Apts., Denver, Col.
MAUGHAN, Allan, M.E., '06. (1) 217 Clarence St., Sydney, Australia. (2) and (3) Care Australian General Electric Co., Sydney, Australia.
MAULL, George Thomas, '05. Box 154, Lewes, Del.
de MAURIAC, Guy Miremont, '02. Allendale, N. J.
MAURY, Alfred Blake, M.E., '15. Care Mechanical Supt. of Erie R. R. (2) and (3) 50 Church St., New York City. (1) Washington Pl., Morristown, N. J.
MAXFIELD, Charles D., M.E., '12. Asst. Elec. Engr., Whitney Point, N. Y. (1) 41 Butler Ave., Bridgeport, Conn. (2) Care Bryant Elec. Co., Bridgeport, Conn.
MAXWELL, E. J., M.E., '14. 121 Broadway, Tarrytown, N. Y.
MAXWELL, Howard, '05. 986 Dryden Rd., Columbus, O.
MAXWELL, Max Carson, M.E., '00. Care Yale & Towne Mfg. Co., Stamford, Conn.
MAXWELL, Walter Landon, M.E., '15. Box 777, Anaconda, Mont.
MAXWELL, Wellwood Hugh, '10. 98 Westfield Ave., Westfield, N. J.
MAXSTADT, Francis W., M.E., '16. Monroe, N. Y. A. I. E. E.
MAY, Charles Culbertson, '10. 5501 21st Ave., N. E. Seattle, Wash.
MAY, Walter Alfred, M.E., '94. 5 & Liberty Sts., Pittsburg, Pa.
MAYER, Karl Herman, M.E., '15. (1) 803 Lenox Hotel, Detroit, Mich. (2) Timken-Detroit Axle Co., Detroit, Mich.
MAYERS, Wilbur Shirley, '92. Care Consolidation Coal Co., Fairmont, W. Va.
MAYNARD, Albert Ackley, M.E., '15. Greenport, N. Y.
MAYNARD, Daniel, '98. Address not known.
MAYNARD, Wilbur Allen, '96. Asst. Bursar, Yale University. 68 Gilbert Ave., New Haven, Conn.
MAYO, Edward H., M.E., '05. Consulting Engr., Indianapolis, Ind. (2) and (3) 1216 Fletcher Savings and Trust Bldg. (1) 1824 Broadway, Indianapolis, Ind.
MAYTHAM, Walter John, M.E., '02. Care Northwestern States Portland Cement Co., Mason City, Iowa.
MEANS, Kenneth Draper, M.E., '13. Care Am. Tar Products Co., Syracuse, N. Y.
MEARS, Arthur Maxwell, '10. 49 N. 17th St., Portland, Ore.
MEARS, John Farnham, '06. Executor. (1) 800 Clay Ave., Scranton, Pa. (2) Mears Bldg., Scranton, Pa.
MECHLING, Benjamin Franklin, jr., '05. 370 Church Lane, Germantown, Philadelphia, Pa.
MECKE, Henry Emil, '11. Emerson Hill, Stapleton, N. Y.
MEDDAUGH, Samuel A., M.E., '04. Jr. Mech. Engr., U. S. Army Engrg. Dept. (2) and (3) P. O. Box 349 (Room 407 Federal Bldg.), Cleveland, Ohio. (1) 1567 Orchard Grove Ave., Lakewood, O.
MEEHAN, John Augustin, '99. Address not known.
MEEKER, Gardner, '92. 95 Clay St., Newark, N. J.
MEEKER, Lewis E., jr., M.E., '04. Commerical Engineer. (2) 15 Dey St., New York City. (1) and (3) 43 Linden St., Brooklyn, N. Y. A. I. E. E., Tel. Soc. of N. Y.
MEEKER, Warren H., M.E., '91. Professor. Iowa State College, Ames, Ia.
MEIKLE, John Holson, jr., M.E., '94. Morrisburg, Ont., Can.
MEINELL, John Bradford, '09. 202 W. 102d St., New York City.
MEINHARDT, Emil William, '96. Balfour, N. Dak.
MEISSNER, Harold Gustav, M.E., '17. 45 Lenox Rd., Brooklyn, N. Y.
MEISSNER, Scott Thaddeus, M.E., '06. 808 Wohm Bldg., Duluth, Minn.
MEISTER, James Franklin, M.E., '05. 3840 Olive St., Kansas City, Mo.
MEJIA, Miguel, '13. Address not known.
MELDRUM, Alfred Smith, M.E., '11. Am. Steel Foundries, Franklin, Pa.
MELLOWES, Alfred W., M.E., '06. Vice-President Gen. Mgr. (2) and (3) Guardian Frigerator Co. (1) 1274 12th St., Detroit, Mich.
MELTZER, Irving (Isidor) Karnell, '10. 950 Leggett Ave., New York City.

MELVILLE, MAINOR STUART, M.E., '12. Care Benedict Mfg. Co., East Syracuse, N. Y.
MELVIN, CARROLL L., M.E., '07. (1) 16 E. Corydon St., Bradford, Pa. (2) and (3) 16 E. Corydon St., Bradford, Pa.
MENDENHALL, SAMUEL ACHILLES, M.E., '94. Bozeman, Mont.
MENDINHALL, EDW., M.E., '16. 649 Y. M. C. A. Bldg., Detroit, Mich.
MENGE, SIDNEY LAWRENCE, '06. Dept. Manager, Woodward, Wight & Co., New Orleans, La.
MENGES, HARRY P., M.E., '10. Rolling Mills. (2) Jones & Laughlin, Southside, Pittsburg, Pa. (1) and (3) 3420 Parkview Ave., Pittsburg, Pa.
MENGES, THEODORE CHARLES, M.E., '94. Gen. Supt., Associated Mfgrs. Co. (1) 303 South St., Waterloo, Ia. (2) and (3) Waterloo, Iowa.
MENNEN, WILLIAM GERHARD, M.E., '08. (1) 727 High St., Newark, N. J. (2) and (3) Care Gerhard Mennen Chemical Co., Newark, N. J.
MENOUGH, PAUL SIMPSON, M.E., '07. 1120 Riverside Ave., Wellsville, O.
MERGENTHALER, EUGENE GEORGE, '07. Marlborough Apartments, Baltimore, Md.
MERINO, E. E., M.E., '15. 38 E. Cerra St., Santurce, P. R.
MEROWIT, WILLIAM GRANT, M.E., '11. Mgr. Elec. Dept. (2) and (3) Care W. Johns Manville Co., 501 N. 3d St., St. Louis, Mo. (1) 3957 Westminster Pl., St. Louis, Mo.
MERRICK, EDGAR HAMILTON, M.E., '08. Sec. and Sales Mgr. (1) 503 W. 3d St., Mishawaka, Ind. (2) and (3) Perkins Windmill & Eng. Co., Mishawaka, Ind.
MERRICK, JOHN FINNEY, M.E., '17. 95 Arkledun Ave., Hamilton, Ont., Canada.
MERRIHEW, LELAND A. H., M.E., '10. Mgr. The Strong, Carlisle & Hammond Co. (2) and (3) 200 Congress St., Cambridge, Mass. (1) 6 Brewster St., Cambridge, Mass.
MERRILL, EDWARD WHITE, JR., '93. Maspeth, N. Y.
MERRILL, GEORGE BARTGES, M.E., '03. 688 Diagonal Rd., Akron, O.
MERRILL, GEORGE HENRY, M.E., '96. 469 Greene Ave., Brooklyn, N. Y.
MERRILL, JAMES HUSE, Sp. M., '02. Care South American Con. Co., La Paz, Bolivia, S. A.
MERRILL, WHITNEY, M.E., '03. 2023 Bedford Ave., Brooklyn, N. Y.
MERRITT, ERNEST GEORGE, M.E., '86. Professor. (2) Cornell University, Ithaca, N. Y. (1) and (3) 39 East Ave., Ithaca, N. Y. American Physical Society, A. A. A. S., Sigma Xi, Tau Beta Pi.
MERRITT, LOUIS GILBERT, M.E., '89. 290 West Ave., Lockport, N. Y.
MERRY, WILLIAM LINCOLN, '15. 215 Maple Ave., Rockville Center, N. Y.
MERZ, CHARLES FREDERICK, M.E., '12. Tacony, Philadelphia, Pa.
MERZ, HAROLD BAKER, M.E., '14. Tacony, Philadelphia, Pa.
MESICK, DAVID WILSON, B.M.E., '80. 98 Hicks St., Brooklyn, N. Y.
MESSER, PAUL, M.E., '94. Mgr. Eng. Dept., Am. Trading Co., 110 Bluff, Tokohama, Japan. Sigma Xi, Japanese Inst. of Mech. Engrs., Amer. Soc. of Mech. Engrs., Amer. Inst. of Mining Engrs.
MESSERSMITH, ARTHUR HENRY, '13. 329 Elmwood Ave., Buffalo, N. Y.
METTEE, CARROL RUSSELL, M.E., '08. Asst. Engr. Elec. Dept. (2) B. & O. R. R., Baltimore, Md. (1) and (3) Homewood Apts., Charles and 31st St., Baltimore, Md.
METTENET, FRANCIS XAVIER, M.E., '12. 6220 Blackstone Ave., Chicago, Ill.
METZ, WALTER RICHARD, M.E., '97. (2) and (3) Supt. of Bldgs. Government Printing Office, Washington, D. C. (1) 717 Massachusetts Ave., N. E., Washington, D. C. A. S. M. E., Wash. Soc. of Engrs.
METZGER, LEWIS WALLACE, M.E., '09. Designing Engr., Structrual Eng. (2) and (3) Oregon State Highway Commission, Salem, Ore. (1) 375 Division St., Salem, Ore. Oregon Soc. of Engineers.
MEYER, CARL F., M.E., '08. Sales Mgr., Landis Machine Co. (1) Waynesboro, Pa. (2) and (3) 10 Mt. Airy Ave., Waynesboro, Pa.
MEYER, GEORGE CHARLES, ME., '17. 522 Tremont St., Rochester, N. Y.
MEYER, RICHARD CONWAY, M.E., '11. Plant Dept. Bell Tel. Co. Penn. (1) 4520 Walnut St., Philadelphia, Pa. (2) and (3) 1230 Arch St., Philadelphia, Pa.
MEYER, ROBERT OLIVER, M.E., '17. 1921 Virginia Ave., St. Louis, Mo.
MEYER, WILLIAM MAX, '10. 804 Auburn Ave., Buffalo, N. Y.
MEYERS, ALFRED HILDEBRAND, '92. Water Co., Columbia, Pa.
MEYERING, BERNARD, M.E., '15. 241 Glenwood Ave., Rochester, N. Y.
MEYLER, R. G., M.E., '16. 2713 Severance St., Los Angeles, Cal.
MEYSENBURG, ROBERT CARR, M.E., '99. Care Amer. Car & Foundry Co. Chicago, Ill.
MICKLE, JOHN DANIEL, '93. 906 Univ. Blk., Syracuse, N. Y.
MICKLE, ROBERT THOMAS, M.E., '92. (1) 430 Stafford St., Germantown, Philadelphia, Pa. (2) and (3) Drexel Bdlg., Philadelphia, Pa.
MICOU, HILARY HERBERT, M.E., '15. 31 W. Palmer St., Detroit, Mich.
MICHAEL, WILLIAM CUTTER, '03. Address not known.
MIDDLEDITCH, LYMAN, M.E., '05. Designer, Printing Machinery. (2) and (3) 65 Duane St., New York City. (1) 35 Walworth Ave., Hartsdale, N. Y.
MIDGLEY, FREDERICK WM., M.E., '98. Chief Draftsman, Otis Elevator Co. (2) 26 St. and 11 Ave., New York City. (1) and (3) 11 Saratoga Ave., Yonkers, N. Y. A. S. M. E.
MIDGLEY, THOMAS, JR., M.E., '11. R. F. D. Worthington, O.
MILES, JOHN JAMES, M.E., '09. 414 Biddle Ave., Wilkinsburg, Pa.
MILES, JOSEPH WALTER, M.E., '93. Irwin, Pa.
MILLAR, ROGER ALEXANDER, M.E., '00. (1) Bala Ave. and Pembroke Rd., Cynwyd, Pa. (2) and (3) District Mgr., Kerr Turbine Co., 1216 Stock Exch., Bldg Philadelphia, Pa.
MILLARD, ERNEST HORATIO, M.E., '16. 416 Wyo. Ave., Kingston, Pa. A. I. E. E.
MILLARD, JOHN ROOSA, '88. Manufacturer. Kingston, N. Y.
MILLARD, THOMAS CHEEVER, JR., '07. Sec. Connecticut Hat Mfg. Co. Danbury, Conn.
MILLER, ARTHUR FREDERICK, M.E., '05. Address not known.
MILLER, ADDISON, '11. 803 Lincoln Ave., St. Paul, Minn.
MILLER, ALFRED HARMER, '05. 1420 Chestnut St., Philadelphia, Pa.
MILLER, BURT A., '95. 923 Illuminating Bldg., Cleveland, O.
MILLER, BENJAMIN HAROLD, M.E., '13. Advertising. (2) and (3) 97 Chambers St., New York City. (1) 14 West 52d St., New York City.
MILLER, CHARLES DUDLEY, '11. 226 W. 70th St., New York, N. Y.
MILLER, CLARENCE ANDERSON, M.E., '11. 274 W. 4 St., Mansfield, O.
MILLER, DANIEL, '08. Chemist, (2) and (3) Consolidated Gas, Electric Light & Power Co. Baltimore, Md. (1) 2526 St. Paul St., Baltimore, Md. Amer. Gas Inst., Am. Chem. Soc., Nat. Elect. Light Assoc.
MILLER, DAVID DEPPEN, '06. Mfgr., 836 N. Cleveland Ave., Canton, O.
MILLER, DONALD CAMERON, M.E., '12. 949 W. 8th St., Erie, Pa.
MILLER, F. B., M.E., '13. 6 Lloyd Rd., Montclair, N. J.
MILLER, FREDERICK, M.E., '06. 422 First Ave., Mt. Vernon, N. Y.
MILLER, JOHN VINCENT, '01. Care Edison Laboratory, Orange, N. J.
MILLER, HENRY HALSEY, '11. 510 Bird Ave., Buffalo, N. Y.
MILLER, HARRY J., M.E., '07. Ass. Sec. and Sales Agent, Pittsburgh Steel Co. (2) and (3) Frick Bldg., Pittsburgh, Pa. (1) 6107 Kentucky Ave., Pittsburgh, Pa.
MILLER, HERMAN GOTTLIEB, M.E., '96. Mech. and Refrigerating Engr. (2) 1021 W. Boone Ave., Spokane, Wash. (1) and (3) E. 3257 14th Ave., Spokane, Wash.. A. S. M. E.
MILLER, JAMES GILBERT, M.E., '14. Yoncalla, Ore.
MILLER, KEMPSTER BLANCHARD, M.E., '93. Care McMeen & Miller, Chicago, Ill.
MILLER, LORIMER DOUGLASS, M.E., '96. Elec. Engineer, Engineer Dept. U. S. A. (2) Engineering Depot, Washington Barracks. (1) and (3) 1458 Belmont St., Washington, D. C. A. I. E. E.
MILLER, MAX JOHN, '13. R. F. D. 5, Ogdensburg. N. Y.
MILLER, MILTON CHENEY, '99. Allis Chalmers Bullock Co., Chicago, Ill.
MILLER, OSCAR GEORGE, M.E., '11. Care Standard U. S. Cable Co. 50 Church St., New York, N. Y.
MILLER, RANSOM GURDEN, '13. 13430 Graham Ave., Cleveland, O.
MILLER, SERENO GLASSELL, M.E., '08. Head Engineering Dept., New Bedford Textile School. (2) 1171-1219 Purchase St. (1) and (3) 490 Union St., New Bedford, Mass. A. S. M. E.
MILLER, STANLEY NATHANIEL, M.E., '12. 1818 W. Madison St., Chicago, Ill.
MILLER, THOMAS LEO, M.E., '10. Care Sangamo Electric Co., 50 Church St., New York City.
MILLER, WILLIAM BOOTH, M.E., '99. 231 Thorn St., Sewickly, Pa.
MILLER, WILLIAM HENRY, ME., '13. Room 632, 1421 Arch St., Philadelphia, Pa.
MILLER, WILLIAM RAYMOND, M.E., '99. Care B. F. Goodrich Co., Akron, O.
MILLS, JAMES EVANS, M.E., '14. 422 W. Marquette Rd., Chicago, Ill.
MILLS, S. D., M.E., '13. Mgr. Casualty & Bond Dept. (1) Summit Ave., Summit, N. J. (2) Fidelity & Deposit Co. of Maryland, Terminal Bldg., Oklahoma City, Okla.
MILLS, THEO. HEINS, '13. 1128 Logan St., Tyrone, Pa.
MILLIKEN, ALBERT EVANS, '94. 1168½ West Edgeware Rd., Los Angeles, Cal.
MILHEIM, ELMER, '02. Address not known.
MILMOE, MICHAEL JOSEPH, M.E., '97. (1) 107 S. Sagamon St., Chicago, Ill. (2) and (3) Care F. B. Redington Co., 112 S. Sangamon St., Chicago, Ill.
MILNER, HARRY RICHARDSON, '97. 100 Boylston St., Boston, Mass.
MILNOR, THOMAS WILLIAM, M.E., '89. 32 S. 5 St., Allentown, Pa.
MILTENBERGER, GEORGE KERR, M.E., '11. The Elec. Co. of Missouri, Webster Groves, Mo.
MILTON, ALONZO LORING, M.E., '15. Inspector in Shrapnel Dept. of Wheeling Mould and Foundry Co. Elm Grove, W. Va.
MINTON, OGDEN, M.E., '08. 186 Washington Pk., Brooklyn, N. Y.
MINTZ, JAY JEROME, M.E., '07. 551 W. 157 St., New York City.
MIRICK, CARLOS B., M.E., '05. Vice-Pres. Natl. Elec. Supply Co. (2) and (3) 1330 New York Ave., Washington, D. C. (1) 1638 R., N. W., Washington, D. C.
MISKELLA, WILLIAM JAMES, M.E., '05. (1) 2443 Flournoy St., Chicago, Ill. (2) and (3) 334–338 S. Clinton St., Chicago, Ill.
MITCHELL, CHARLES COFFIN, M.E., '98. Millbrook, N. Y.
MITCHELL, FRANCIS, '10. 911 West End Ave., New York City.
MITCHELL, JAMES BRADY, '95. Commander. Ft. Grant, Panama, Canal Zone.
MITCHELL, JOHN HENNON, '95. Old Colony Bldg., Chicago, Ill.
MITCHELL, JAMES LAWRENCE, '11. 3303 Reading Rd., Cincinnati, O.
MITCHELL, RICHARD HENRY, '76. Farmer. Oak Summit, N. Y.
MITCHELL, WILLIAM CHURCHILL, '09. Address not known.
MITCHELL, WILLIAM ELLIS, '04. Address not known.
MITCHELL, WALTER R., M.E., '06. 863 Park Ave., Baltimore, Md.
MILTER, HERBERT ERNEST, M.E., '08. (1) 300 W. 109 St., New York City (2) and (3) In building business, 681 5th Ave., New York City.
MIX, DAVID CAMERON, M.E., '05. 190 Wright Ave., Toronto, Ont., Can.
MIXSELL, DAVID ROY, M.E., '10. 38 Church St., Little Falls, N. Y.
MIZUSHI, F. MASANAO, M.M.E., '15. 501 Penwood Ave., Wilkinsburg, Pa. A. I. E. E., Sigma Xi.
MOCHRIE, ROBERT, M.E., '15. 409 W. 261 st St., New York City.
MODE, HERBERT COMLY, M.E., '97. 421 Ross Ave., Wilkinsburg, Pa.
MOFFAT, HAROLD WELLINGTON, M.E., '10. Marine Dept., Maryland Steel Co. (2) and (3) Sparrows Point, Md. (1) 476 Main St., Orange, N.J.
MOFFATT, JAMES, M.E., '14. Care Aluminum Casting Co., 950 N. Pennsylvania St., Indianapolis, Ind.
MOFFETT, WILLIAM STUART, '05. Heating Engineer. (2) and (3) Staunton, Va. (1) R. F. D. 3, Staunton, Va.
MOHAN, WILLIAM THOMAS, '98. Philadelphia, Pa.
MOHUNDRO, W. E., M.E., '15. Elm St., Clarkston, Wash.
MOLÉ, HARVEY E., M.E., '97. Consulting Engr. (2) and (3) 55 Liberty St., New York City. (1) Summit, N. J. A. I. E. E., A. S. M. E., Nat. Elec. Light Assn.
MOLLESON, GILBERT COX, M.E., '13. Asst. in Dept. Tests & Inspection. (2) and (3) Care Office Engr. Tests, Atchison, Topeka & Santa Fe Ry., Topeka, Kan. (1) 1035 Quincy St., Topeka, Kan.
MOLLMAN, RUDOLPH CLARENCE, '96. Address not known.
MOLER, GEORGE SYLVANUS, B.M.E., '75. Professor Cornell University. 408 University Ave., Ithaca, N. Y.
MOLONY, HARMAN MARTIN, M.E., '17. 2427 N. 54th St., Philadelphia, Pa.
MONROE, JAMES, M.E., '09. 330 Gowen Ave., Mt. Airy, Philadelphia, Pa.
MONROE, WILLIAM STANTON, '90. (1) 64 E. Elm St., Chicago, Ill. (2) Care Sargent & Lundy, 72 W. Adams St., Chicago, Ill. A. S. M. E.
MONTAGUE, CHARLES EUGENE, M.E., '09. 129 W. Castle St., Syracuse, N. Y.
MONTAGUE, DWIGHT PRESTON, '76. 149 E. Terrace St., Chattanooga, Tenn.
MONTEITH, CHARLES DUNCAN, M.E., '12. Asst. Supt. of Operation and Maintenance. (2) Northwestern Elect. Co., Portland, Ore. (1) and (3) R. F. D. 1, Box 6A, Milwaukee, Ore.
MONTGOMERY, CHANDLER, M.E., '12. 704 Weston Reserve Bldg., Cleveland, Ohio.
MONTGOMERY, DUDLEY, M.E., '06. (1) 632 Howard Pl., Madison, Wis. (2) and (3) S. Wis. Ry. Co., Madison, Wis.
MONTGOMERY, JAMES JOSEPH, C.E., '03. (1) 539 N. 33 St., Philadelphia, Pa. (2) and (3) Care Bureau Highways, Philadelphia, Pa.
MONTGOMERY, STAFFORD, M.E., '09. E.E., M.E., M.Sc., Cons. Industrial Engr. and Wks. Economist. (2) Chicago, Ill. (1) and (3) Riverside, Ill. A. I. E. E., A. S. M. E., Efficiency Soc., Nat. Safety Council, Am. Acad. Pol. & Social Sci., C. U. Assn., Chicago, A. A. Advance Soc.
MONTGOMERY, WARREN, '04. Madison St. Ry. Co., Madison, Wis.
MOODY, ARTHUR EDSON BLAIR, '94. Address not known.
MOODY, NELSON KINGSLAND, M.E., '99. 300 S. 4th St., Independence, Kan.
MOODY, VIRGINIUS DANIEL, M.E., '00. 25 Broad St., New York, N. Y.
MOODY, WILLIAM FALLEY, M.E., '02. 37 S. Croton Ave., New Castle, Pa.
MOORE, ELBERT OWEN, M.E., '04. Address not known.
MOORE, HERBERT FISHER, M.E., '99, M.M.E., '03. Asst. Prof. Univ. of Ill., Urbana, Ill.
MOORE, JAMES H., M.E., '16. (2) and (3) Amer. T. & Tel. Co., 195 Broadway. (1) 502 W. 139 St., New York City. A. I. E. E.
MOORE, JOHN THOMAS, JR., M.E., '10. 575 College St., Macon, Ga.
MOORE, RALPH SWITZER, M.E., '99. Address not known.
MOORE, THOMAS RAMON, '79. Address not known.
MOORE, WILLIAM ALEXANDER, M.E., '09. Electrical Engr. Hartsdale Rd., Elmsford, N. Y.
MOORE, WILLIAM GEORGE, '06. 12 Thorn St., Sewickley, Pa.

MOORES, Merrill Bruce, M.E., '07. 281 E. 15 St., Portland, Ore.

MOORMAN, William Glass, M.E., '08. Portsmouth Eng. Co., Portsmouth, O.

MORAN, August Herman, '17. 525 Elm St., Buffalo, N. Y.

MORAN, Harry Powell, M.E., '03. 177 Montague St., Brooklyn, N. Y.

MORAN, John Malcolm, '06. Pres. Moran Mfg. Co. 1220-22 First Ave., South, Seattle, Wash.

MORBIO, Adolph, M.E., '13. Care Great Western Power Co., San Francisco, Cal.

MORDOCK, Charles Teere, M.E., '97. Mgr. J. G. White & Co. (1) 611 Oak St., Winnetka, Ill. (2) and (3) 1256 First Natl. Bldg., Chicago, Ill. A. I. E. E., Ill. Eng. Soc.

MORDOFF, William Emerson, M.E., '13. Instructor. (2) Sibley College Cornell Univ., Ithaca, N. Y. (1) 215 Kelvin Place, Ithaca, N. Y.

MORE, William Alger, M.E., '13. Sec. G. E. More Co. (2) and (3) 11 W. Eagle St., Buffalo, N. Y. (1) 8 Soldiers Place, Buffalo, N. Y.

MOREHOUSE, Alanson David, M.E., '93. (1) 1526 O St., N. W., Washington, D. C. (2) and (3) Drainage Engr., U. S. Dept. of Agrl., Washington, D. C. Wash. Soc. of Engrs.

MOREHOUSE, Herbert Harrison, M.E., '89. Raising Fruit in N. Car. (1) (2) (3) Oakwoods, Wilkes Co., North Carolina. A. S. E. E.

MORGAN, Charles Grier, M.E., '98. Superintendent. Morris Run. Coal Min. Co., Morris Run, Pa.

MORGAN, Charles Grover, M.E., '15. Address not known.

MORGAN, Elias Franklyn '92. Launderer, Pres. The E. F. Morgan Co. New London, Conn.

MORGAN, George Rose, '16. Student, Engr. (2) General Electric Co., Schenectady, N. Y. (1) 305 E. North St., Greenville, S. C. (3) Chi Psi Lodge, Schenectady, N. Y. A. I. E. E.

MORGAN, John Hefrich, '10. 79 S. Highland Ave., Ossining, N. Y.

MORGAN, Llewellyn, M.E., '00. 784 Quincy St., Brooklyn, N. Y.

MORGAN, Porter Southwick, '13. Highwood, Norwalk, Conn.

MORGAN, William Albery, jr., M.E., '05. Telephone Engineer. (1) 310 First St., Westfield, N. J. (2) 15 Dey St., New York City.

MORGAN, Wilfred Ryan, M.E., '96. 526 Holley Ave., St. Paul, Minn.

MORGAN, William Conant, M.E., '06. 45 Albert St., Plainfield, N. J.

MORGANSTERN, Morris, M.E., '07. Address not known.

MORGENSTERN, William Clarence, M.E., '10. 308 Dunlap Ave., N. E., Pittsburg, Pa.

MORGENTHAU, John Lewis, '11. 155 W. 77 St., New York City.

MORLEY, Edgar Lewis, M.E., '92. 571 5th Ave., New York City.

MORRELL, Robert Whiting, M.E., '09. Room 106, 26 Broadway, New York City.

MORRILL, Vaughan, '14. 306 N. East St., Tacoma, Wash.

MORRIS, Dwight Elmer, '11. 411 William St., East Orange, N. J.

MORRIS, George Hall, M.E., jr., '10. 538 W. 23 St., New York, N. Y.

MORRIS, George Linn, '07. (1) 5627 Carlton Way, Los Angeles, Cal. (2) and (3) 447 49 E. 3d St., Los Angeles, Cal.

MORRIS, Guy Turner, M.E., '12. Asst. Examiner in Patent Office. (1) and (3) 2625 Garfield St. N. W., Washington, D. C. (2) Patent Office.

MORRIS, John Samuel, M.E., '17. Denison, Tex. Tau Beta Pi.

MORRIS, Rexford Lansing, M.E., '17. 92 Winton Rd. S., Rochester, N. Y.

MORRIS, Windsor, '93. Machine Works. Baldwinsville, N. Y.

MORRISON, Archibald Bostwick, jr., M.E., '01. Care Hoehler, Cummins & Prudden, 2 Natl. Bank Bldg., Toledo, Ohio.

MORRISON, Clark, jr., '05. The Palladium, 60 W. Mohawk St., Oswego, N. Y.

MORRISON, Clarke John, M.E., '01. 149 Broadway, New York, N. Y.

MORRISON, Herbert Hunt, M.E., '98. Board of Education, St. Louis, Mo.

MORRISON, James, M.E., '03. 750 Ludlow Ave., Clifton, Cincinnati, O.

MORRISON, William Newton, jr., '96. 4556 Morgan St., St. Louis, Mo.

MORRISON, William, M.E., '94. 750 Ludlow Ave., Clifton, Cincinnati, O.

MORROW, Charles Edwin, '81. Address not known.

MORROW, Homer Nicholas, '09. Tobacconist, 821 Franklin St., Clarksville, Tenn.

MORROW, Joseph Caldwell, jr., '08. 728 N. Negley Ave., Pittsburg, Pa.

MORROW, Lester W. W., M.E. '11. Consulting Engr.; Assoc. Prof. and Asst. Director. School of Elect. Engrg., Univ. of Oklahoma. (2) and (1) Norman, Oklahoma. A. I. E. E., S. P. E. E. Acacia, Sigma Tau.

MORROW, Percy Colder, '97. Address not given.

MORROW, Preston Knox, '05. 27 Beach St., East Orange, N. J.

MORSE, Albert Wethers, M.E., '08. Vice-Pres. The Anthony Co. (1) 99 Meserole Ave., Greenpoint, Brooklyn. (2) and (3) 138 West Ave., Long Island City, N. Y. A. I. E. E., A. S. M. E.

MORSE, George Westlake, '95. M.D. Denver & Gross M.D. Coll., 1900. Surgeon, Unintah Ry. Co., Dragon, Utah. Care Unintah Ry. Co.

MORSE, Everett Ralph, '15. 111 Eddy St., Ithaca, N. Y.

MORSE, Raymond, P., M.E., '03. Sec. Edwin C. Burt Co., Shoe Mfrs. (2) and (3) 59 Jay St., Brooklyn, N. Y. (1) 166 Gates Ave., Brooklyn, N. Y.

MORSE, Lawrence Gordon, '06. Mech. Engr., 2323 N. 16 St., Philadelphia, Pa.

MORSE, Robert Virgil, M.E., '11, LL.B., '15. 512 Edgewood Pl., Ithaca, N. Y.

MORSS, Dwight Foster, M.E., '11. Salt Springs Rd., Syracuse, N. Y.

MORTIMER, Charles W., M.E., '07. Pat. Office Examiner. (2) and (3) Pat. Office, Washington, D. C. (1) 1434 Harvard St., Washington, D. C.

MORTON, Clarence Garfield, '05. Manufacturer. Member firm of Paris Mfg. Co. South Paris, Maine.

MORTON, Jas. A., M.E., '09. Asst. Mech. Engr., Am. Steel & Wire Co. (2) 1165 Frick Bldg. Annex, Pittsburgh, Pa. (1) and (3) 401 Marshall Ave., Pittsburgh, Pa.

MORTON, Neil, '05. Groton, N. Y.

MOSES, Adolph, M.E., '15. 228 Westchester Ave., Mt. Vernon, N. Y.

MOSES, Cluster Davis, M.D., '02. Physician and Surgeon. 168 Lafayette Ave., Buffalo, N. Y.

MOSHER, Guy Walter, M.E., '07. Cold Spring, N. Y.

MOSLER, Henry Gustav, M.E., '10. Mech. Engr. Mosler Safe Co., Hamilton, O.

MOSS, Sherwood Conkling, '06. 21 Colonial Circle, Buffalo, N. Y.

MOSSCROP, Thomas Arrowsmith, '93. Vineland, N. J.

MOSSCROP, William Addams, M.R., '88. (1) 812 Prospect Pl., Brooklyn, N. Y. (2) and (3) Engr. of Supplies, N. Y. Telephone Co.

MOTHERSHEAD, John Leland, jr., M.E., '03. 721 St. John Ave., Pasadena, Cal.

MOTOKAWA, I., M.E., '16. 333 Barnes St., Wilkinsburg, Pa.

MOTT, Abram C., jr., '00. 1st Vice-Pres. Abram Cox Stove Co. (1) and (3) "The Woods," Lansdale, Montgomery Co., Pa. (2) American & Dauphin Sts., Philadelphia, Pa. A. S. M. E., Efficiency Soc.

MOTT, Stanton, M.E., '11. Sec. and Treas. Walden-Mott Co., Inc., publishers. (2) and (3) 38 Park Row, New York City. (1) 815 Kilsyth Rd., Elizabeth, N. J.

MOTT, Vancleve Charles Shaw, M.E., '95. 391 Delaware Ave., Buffalo, N. Y.

MOULSON, Charles Edward, M.E., '04. (1) and (3) 512 N. Glen Oak Ave., Peoria, Ill. (2) Care Barrett Co., Peoria, Ill.

MOUNCE, Robert S., M.E., '09. Erie Ry. (2) and (3) 50 Church St., New York, N. Y. (1) 115 Washington Ave., Rutherford, N. J.

MOUNT, William D., M.E., '90. Gen. Mgr. Mathieson Alkali Works, Saltville, Va. A. S. M. E., Am. Chem. Soc.

MOURNING, Garland Hubbard, jr., '06. 1332 3d St., Louisville, Ky.

MOWAT, John Frederic, M.E., '06, A.B., '04. Steam Engr., Joliet Works. Ill. Steel Co., Joliet, Ill.

MOWAT, Oliver Mowat, M.E., '89. 1114 Union Ave., McKeesport, Pa.

MOWERY, John Norris, M.E., '99. Care Lehigh Valley R. R., Auburn, N. Y.

MOWRER, Frank Roger, LL.B., '94. Safe Department. (2) Standard Oil Co., 1727 San Fernando St., Los Angeles, Cal. (1) 620 St. Paul Ave., Los Angeles, Cal.

MOXHAM, Egbert, '04. 1204 Rodney St., Wilmington, Del.

MOXLEY, William Francis, M.E., '04. 327 Prescott Ave., Scranton, Pa.

MOYER, Fredellia Hughes, M.E., '99. Address not known.

MOYER, John Clarence, '00. 1030 W. Main St., Norristown, Pa.

MUDGE, Charles Augustus, '97. U. S. L. & H. Co., Niagara Falls, N. Y.

MUDGE, James Douglas, M.E., '04. Mechanical Engineer. (1) 6033 8th Ave., N. E. Seattle, Wash. (2) and (3) Mudge, Huffman & Co., 925 Northern Bank Bldg., Seattle, Wash.

MUDGE, Sterling William, M.E., '13. Efficiency Engr., with E. R. Ladew Co., Inc., Leather Belting. (2) and (3) Glen Cove, L. I., N. Y. (1) Glen Cove, L. I. A. S. M. E.

MUELLER, George Henry, jr. '03. Address not known.

MUELLER, Lucien Wilbur, '17. Decatur, Ill.

MULFORD, Allen, M.E., '15. (2) Care General Electric Company, Schenectady, N. Y. (1) and (3) Alpha Delta Phi House, Union College, Schenectady, N. Y.

MULL, James Martin, M.E., '09. Wilpen, West Moreland Co., Pa.

MULLAN, Frank Drexel, '97. The Club Fellow, 1 Madison Ave., New York City.

MULLER, Edward Claus, '12. (2) and (3) Care Crouse Hinds, 30 Church St., New York City. (1) 1057 Nostrand Ave., Brooklyn, N. Y.

MULLER, Enrique Keutsch, M.E., '97. R. F. D. 7, Ithaca, N. Y.

MULLER, James Frederick, M.E., '04. 414 Rector Ave., Little Rock, Ark.

MULLIGAN, Walter Lyon, '98. (1) 57 Avon Pl., Springfield, Mass. (2) and (3) Gen. Mgr., United Electric Light Co., Springfield, Mass.

MULROY, William Leo, '04. Marcellus, N. Y.

MUMFORD, Wm. Clinton, jr., M.E., '12. Estimating and Cost Dept. (2) and (3) Lidgerwood Mfg. Co., 96 Liberty St., New York City. (1) 144 Lincoln Place, Brooklyn, N. Y.

MUNDAY, Horace Daniel, '96. Canton, Mo.

MUNDEN, Ralph, M.E., '06. U. S. Patent Office, Washington, D. C.

MUNDY, Roswell Flower, M.E., '04. 39 Cortland St., New York, N. Y.

MUNK, William Edward, M.E., '12. 1902 N. Pennsylvania St., Indianapolis, Indiana.

MUNNS, John James, M.E., '14. Care Raymond Concrete Pile Co., 111 W. Monroe St., Chicago, Ill.

MUNOZ, Salvador Enecon, M.E., '92. Granada, Nicaragua.

MUNROE, Edward, M.E., '04. 401 Home Ins. Bldg., Chicago, Ill.

MUNROE, Harold Simmons, '05. Address not known.

MUNSCHAUER, Frederick E., M.E., '07. Supt. Niagara Machine & Tool Works, Sec. Heinz & Munschaunn Refrigerator Works. (1) and (3) 87 W. Balcom St., Buffalo, N. Y. (2) Buffalo, N.Y. Univ. Club of Buffalo.

MURDOCK, Henry Delos, '90. 32 South Ave., Wilkinsburgh, Pa.

MURPHY, James Louis, '92. 319 N. Aurora St., Ithaca, N. Y.

MURPHY, Leo Francis, '09. Heating Engineer. 810 Jefferson Ave. E., Detroit, Mich. A. I. E. E. Secy.

MURPHY, Lin Ernest, '12. 4051 W. 22d St., Chicago, Ill.

MURPHY, Theodore Rhodes, M.E., '10. 1st Lieut. U. S. A. (1) Balboa Heights. (2) Quarry Heights, Panama, Canal Zone.

MURPHY, Timothy Joseph, M.E., '11. 5 Hazlett St., Morristown, N. J.

MURRAY, Charles Edward, M.E., '03. Plant Foreman. (2) and (3) Union Carbide Co. of Canada, Ltd. Welland, Ont. (1) 32 West South St., Wilkes Barre, Pa.

MURRAY, Charles Edward, jr., '14. (1) 306 Greenwood Ave., Trenton, N. J. (2) and (3) Empire Rubber & Tire Co., Trenton, N. J.

MURRAY, Harold Baldwin, M.E., '16. 934 "S." St., N. W., Washington, D. C. G. E. Elec. Co., Schenectady, N. Y. Cosmopolitan Club.

MURRAY, Linwood Asa, M.E., '94, M.M.E., '96. (1) 1348 8 Ave., East Moline, Ill. (2) and (3) Care Marseilles Co., East Moline, Ill.

MURRAY, Royal Hibbert, '10. Address not known.

MURRAY, Mathias Patrick, '09. Office Manager. (2) Overland Binghamton Co., Binghamton, N. Y. (1) and (3) 101 Oak St., Binghamton, N. Y.

MURRAY, W. T. G., M.E., '16. 206 Main St., Binghamton, N. Y.

MURRAY, Wilbur Albion, '06. 903 Mt. Prospect Ave., Newark, N. J.

MUSGROVE, John C., M.E., '03. Engineer, G. E. Co., Heating Device Dept. (2) General Elec. Co., Pittsfield, Mass. (1) and (3) 85 Newell St., Pittsfield, Mass.

MYERS, Curtis Clark, M.M.E., '05. Prof. of Production Engrg. (2) University of Cincinnati, Cincinnati, O. (3) and (1) 3432 Lyeburn Pl. Cincinnati, O.

MYERS, Geo. Frederick, M.E., '12. Hardware Bus., Asst.-Treas. of G. A. Myers & Co., Inc. (2) and (3) 61 and 63 Washington St., Paterson, N. J. (1) 231 E. 30th St., Paterson, N. J.

MYERS, Howard Charles, '99. Address not known.

MYRICK, James Austin, M.E., '14. Chief Inspector, 53d St. Works. (1) 83 Downing St., Brooklyn, N. Y. (2) and (3) Care E. W. Bliss Co., 53 and 1st Ave., Brooklyn, N. Y.

NACHMAN, Albert Louis, '05. 140 Shonnard Terrace, Yonkers, N. Y.

NAGEL, Harry Coville, M.E., '04. 818 Holland Ave., Wilkinsburg, Pa.

NAKAGAWA, Tsunezo, M.E., '09. Mech. Dept., College of Science. Waseda Univ., Tokyo, Japan.

NAKAYAMA, Ichi, M.E., '95. Address not known.

NAKAMIGAWA, Tetsushiro, M.E., '14. Care Mitsui & Co. 25 Madison Ave., New York, N. Y.

NAMACK, William Henry, M.E., '01. Mgr., Davison Namack Fdy. Co., Ballston Spa., N. Y.

NAMES, Sewell, C.E., '12. Contr. Engr., Barge Canal Term. 21. 700 Telephone Bldg., Buffalo, N. Y.

NASH, Kenneth Hugh, M.E., '12. Garage and Repair Shop. (1) 1601 S. St., N. W. Wash, D. C. (2) 710 O. St., N. W., Washington, D. C.

NASH, Robert Arthur, '15. Bernardsville, N. J.

NATHAN, Alfred, '88. 92 Liberty St., New York City.

NATHAN, Walter Robert, '11. Address not known.

NAUGLE, John Frank, M.E., '16. Electrical Engr. with Continental Motors (1) and (3) 610 Tennyson Ave., Detroit, Mich. A. I. E. E.

NAUSS, George M., '07. Metallographist. (2) Penn. R. R., Test Dept., Altoona, Pa. (1) and (3) 1107 16th Ave., Altoona, Pa.

NEAL, William Russell, '97. Address not known.

NEALE, Harry Taylor, '09. Insurance and Real Estate, 300 Calder Bldg., Harrisburg, Pa.

NEARY, James Eugene, M.E., '06. 91 Rossiter St., Dorchester, Mass.

NEAVE, Pierson, M.E., '02. Telephone Engr., West. Elect. Co. (2) 463 West. St., New York City. (1) and (3) 46 Highland Ave., Glen Ridge, N. J. A. S. M. E., Telephone Soc. of N. Y.

NEDHAM, Stanley Cromwell, '09. Address not known.

NEELY, John Crosby, '99. (2) and (3) 16 S. La Salle St., Chicago, Ill. (1) 4929 Greenwood Ave., Chicago, Ill.

NEELY, Robt. Johnson, M.E., '01. Marine Engine & Boiler Draftsman. (2) U. S. Navy Yard, Norfolk, Va. (1) and (3) 202 North St., Portsmouth, Va. Am. Soc. Marine Draftsmen.

NEE, John Jacob, M.E., '86. Address not known.

NEILSON, Frederick Charlesworth, M.E., '98. 3 Westland Ave., West Hartford, Conn.

NEILSON, George William, M.E., '06. Asst. Treas. and Sec. Lajoris Chem. Co. (2) and (3) Lajoris Chemical Co., Minneapolis, Minn. (1) 2511 Hennepin Ave., Minneapolis, Minn.

NELLEGAR, Jay Cromwell, '98. Salesman. Link Belt Co. 39 and Stewart Ave., Chicago, Ill.

NELLIGAN, Maurice John, '14. Towson, Md.

NELLIS, Franklyn Edward, jr., '04. Member firm F. E. Nellis & Co. 111 W. South Water St., Chicago, Ill.

NELSON, Henry Clay, M.E., '92. Elec. Engr. (2) 30 Church St., New York City. (1) and (3) 545 W. 148 St., New York City.

NELSON, John Edson, M.E., '10. 18 Harrison St., Poughkeepsie, N. Y.

NELSON, John Franklin, '91 Rockford, Ill.

NESSLER, Robert Percy, '11. Care D. E. Sicker & Co., 21st near 6th Ave. New York City.

NETZORG, Charles Solomon, M.E., '05. Kabo Corset Co., Milwaukee Ave. and Carpenter St., Chicago, Ill.

NEUBAUER, George August, M.E., '15. Mech. Eng. for the Buffalo Pitts. Co. (2) Buffalo, N. Y. (1) 339 15th St., Buffalo, N. Y.

NEVILLE, Wilkinson Defrees, '95. Address not known.

NEVIN, William Harbaugh, M.E., '00. 10 S. Raymond St., Pasadena, Cal.

NEVINS, Joseph Nelson, '94. Cons. Mining Engr., 809 S. Los Robbles Ave. Pasadena, Cal.

NEVINS, Roger Griswold, '13. Goodrich Rubber Co., Akron, O.

NEVINS, Thomas Derrel, M.E., '12. W. U. Tel. Co., Dallas, Tex.

NEWBROOK, F. D., M.E., '13. 8 St. Johns Pl., Buffalo, N. Y.

NEWBURY, Frank Davies, M.E., '01. Div. Engr., Westinghouse Elec. Mfg. Co. (2) W. E. & M. Co., East Pittsburg, Pa. (1) and (3) Briar Cliff Road, Pittsburgh, Pa. A. I. E. E., N. E. L. A.

NEWBURY, Edwin Henry, M.E., '01. 536 S. Graham St., Pittsburgh, Pa.

NEWBURY, George Chapman, '06. Goshen, N. Y.

NEWCOMB, Franklin Leroy, M.E., '13. Junior Engr., Standard Oil Co. of N. J. (2) Bayway Refinery, Elizabeth, N. J. (1) and (3) 512 Chilton St., Elizabeth, N. J. A. S. M. E.

NEWCOMB, Wallace R., M.E., '05. Western Electric Co., Chicago, Ill.

NEWCOMB, Robert Cook, M.E., '06. Woonsocket, R. I.

NEWCOMB, Robert Everett, M.E., '07. 229 Chestnut St., Holyoke, Mass.

NEWCOMB, Robert Scott, M.E., '07. Palisades, N. J.

NEWELL, William Tallman, M.E., '15. (2) and (3) Care Newport News Shipbuilding & Drydock Co., Newport News, Va. (1) 121 31st St., Newport News, Va.

NEWKIRK, Edgar Daniel, Spec., '02. 1602 Delaware Ave., Buffalo, N. Y.

NEWMAN, Jacob Kiefer, '92. I. Newman & Son, New Orleans, La.

NEWMAN, John Dundy, M.E., '15. Pacific Coast Mgr. (2) John Thomson Press Co., 1618 Hayes St., San Francisco, Cal. (1) and (3) 324 Rialto Bldg., San Francisco, Cal.

NEWMAN, John Hugho, M.E.,'15. Commonwealth Edison Co., Chicago, Ill.

NEWTON, Jason Howard, '06. Insurance, 34 John St., Springfield, Mass.

NEWTON, Peter Augustin, jr., M.E., '94. (1) 5434 East End Ave., Chicago, Ill. (2) and (3) Care Illinois Steel Co., South Chicago, Ill.

NEWTON, Ralph Henry, '05. 2437 Indiana Ave., Chicago, Ill.

NEWTON, William Buxton, '98. Computer. (2) and (3) Bureau of Steam Engineering, Navy Dept., Washington, D. C. (1) The Cavendish Apt., Washington, D. C. American Soc. of Marine Draftsmen, Washington Soc. of Engrs.

NICHOLLS, William Garland, M.E., '02. 160 Mohawk St., Cohoes, N. Y

NICHOLS, Clayton W., jr., M.E., '06. Treasurer, Atkinson & Co., Cocoa and Choc. (2) and (3) 701 Birch St., Richmond Hill, N. Y. (1) 771 Bedford Ave., Brooklyn, N. Y.

NICHOLS, George Roseman, jr., M.E., '11. 2300 Michigan Ave., Chicago, Ill.

NICHOLSON, Frank H., M.E., '12. Inspector Signals. (2) and (3) Eng. of Signals, N. Y. N. H. & H. R. R., New Haven, Conn. (1) 548 Orange St., New Haven, Conn.

NICHOLES, Daniel Hall, '96. 816 Forest Ave., Wilkmette, Ill.

NICHOLS, Arthur, '79. Mine Mgr., Athens, N. Y.

NICHOLS, Charles Walter, '99. Mfg. Chemist, 406 Clinton Ave., Brooklyn, N. Y.

NICHOLS, Harry Alfred, '95. Lawyer and Sec. Great Bear Spring Co. 2344 Twelfth Ave., New York City.

NICHOLLS, Thomas Henry, '94. 68 Post St., San Francisco, Cal.

NICHOLSON, John Johns, '95. Address not known.

NICKERSON, Charles W., '06. Asst. Naval Constructor, U. S. N. R. F. (1) and (3) 16 Rochelle Place, New Rochelle, N. Y. (2) City Island, N. Y., and Stamford, Conn. A. S. M. E.

NICKERSON, Ralph Richard, M.E., '07. Salesman. (1) 1950 E. 90th St., Cleveland, Ohio. (2) and (3) Worthington Pump and Mchy. Corp., Cleveland, O.

NICKERSON, W. A., M.E., '13. 69 Chestnut St., Ridgewood, N. J.

NIES, John Derk, '04. Lewis Institute, Chicago, Ill.

NIGHTINGALE, Lionel Grenelle, M.E., '09. 202 Lefferts Pl., Brooklyn, N. Y.

NINOMIYA, Teru, M.E., '05. 7 Honmachi, Moji, Japan.

NITCHIE, Hubbard Dunchlee, '97. 1405 Elmwood Ave., Evanston, Ill.

NIVEN, Andrew Freeman, M.E., '11. (1) 55 Broad St., Newark, N. J. (2) and (3) 177 Hudson St., New York, N. Y.

NOCK, Ben Enock, M.E., '12. Care The Nock & Garside Elevator Co., 1850 Wazee St., Denver, Colo.

NOMBURG, Emil, '13. Address not known.

NOON, Francis Charles, M.E., '11. Provo, Utah.

de NORMANDI, Brettiville Gustav, M.E., '13. Inv. Auto. Telescope Touring Apt., Claus Spreckels Bldg., San Francisco, Cal. (2) Owner of Bunker Hill Gold Mine, Sierra Co., Calif. (1) and (3) 1064 Francisco St., San Francisco, Cal.

NORRIS, Henry Hutchinson, M.E., '96. Assoc. Editor, Elect. Ry. Journal. (2) and (3) 239 W. 39th St., New York City. (1) 170 Lorraine Ave., Upper Montclair, N. J. A. I. E. E., Am. Elect. Ry. Ass., Sigma Xi, Eta Kappa Nu, Soc. for the Promotion of Engrg. Education.

NORRIS, George Benson, '13. 601 N. Aurora St., Ithaca, N. Y.

NORRIS, Harold Scott, M.E., '15. 91 Dorchester Rd., Buffalo, N. Y.

NORRIS, John Byrd, jr., M.E., '13. 3111 Clifton Ave., Baltimore, Md.

NORRIS, John Fulton, '07. (1) Anna, Ill. (2) and (3) 410 Wayne Co. Bank Bldg., Detroit, Mich.

NORTH, Harold Diodate, '07. 3005 Coleridge Rd., Cleveland, O.

NORTHROP, Hamilton Fay, '03. 516 W. 136 St., New York City.

NORTHRUP, Burton Earl, '10. 341 Jefferson Ave., Washington, Pa.

NORTHRUP, Lewis Mulford, M.E., '02. (1) 7619 Saginaw Ave., Chicago, Ill. (2) and (3) Illinois Steel Co., Chicago, Ill.

NORTON, Augustus, M.E., '11. 1st Lieutenant, Coast Artillery Corps, U. S. A. (3) Care Adjutant General, Washington, D. C. (1) and (2) Fort Adams, R. I.

NORTON, Alfred Buckley, '94. East Helena, Mont.

NORTON, Clifton Ranney, '01. U. S. Army, War Dept., Washington, D. C.

NORTON, George Robinson, '06. Friendship, N. Y.

NORTON, Harold Frederick, '96. Chief Draftsman Hull Dept. (2) and (3) Newport & News Shipbuilding & Dry Dock Co., Newport News, Va. (1) 323 55th St., Newport News, Va. Sigma Xi, Am. Soc. of Naval Archs. and Marine Engrs., Am. Soc. Marine Draftsmen.

NORTON, Irvin, M.E., '05. Western Elec. Co., New York, N. Y.

NORTON, William J., M.E., '02. Engr., Norton, Bird & Whitman. (2) 111 West Monroe St., Chicago, Ill. (1) Indian Hill Road, Winnetka, Ill. A. I. E. E., Am. Gas. Inst.

NORWOOD, Guy, '98. (1) 1031 W. Market St., Akron, O. (2) and (3) Sec. of Goodrich Co., Akron, O.

NOTTINGHAM, Avon Roberg, M.M.E., '11. 523 W. Mifflin St., Madison Wis.

NOURSE, Ralph Farrington, M.E., '95. U. S. S. Arkansas, N. Y.

NIXDORFF, Samuel Purdy, M.E., '10. Elec. Engr., Gen. Elec. Co. (2) Cons. Engrg. Dept. G. E. Co., Schenectady, N. Y. (1) 18 Hampton Ave., Schenectady, N. Y. A. I. E. E.

NOWAK, Walter William, M.E., '05. 812 Fillmore Ave., Buffalo, N. Y.

NOXON, Gardiner James, '86. 121 N. Aurora St., Ithaca, N. Y.

NOYES, Frederic Jansen, A.B., '10. Care Hemphill, White & Chamberlain, 37 Wall St., New York City.

NUGENT, Harold Arthur, '07. 321 Wyoming Ave., Kingston, Pa.

NUGET, Wm. Post, M.E., '16. Southampton, N. Y.

NULSEN, John Clemence, M.E., '14. Mech. Engr., Missouri Malleable Iron Co., East St. Louis. (1) 5321 Savoy Court, St. Louis, Mo. (2) and (3) Missouri Mal. Iron Co., St. Louis, Mo. Tau Beta Pi.

NYE, Horace B., M.E., '12. Readsboro, Vt.

OATES, Frank Richardson, M.E., '10. Toronto Power Co., Toronto, Ont., Can.

de OBALDIA, Fabio, M.E., '13. David-Chiniqui, Rep. of Panama, C. A.

OBERLY, Robert Shiner, M.E., '08. Fort Hancock, N. J.

OBERRENDER, Stanley Sellman, '06. 243 E. Broad St., Hazleton, Pa.

O'BRIEN, D. H. Employed at Anaconda Co., Great Falls, Montana. Forsyth, Montana.

O'BRIEN, James Joseph, M.E., '07. 514 Elk St., Buffalo, N. Y.

OCHTMAN, Leonard jr., M.E., '15. Asst. Chief Draughtsman Van Blerck Motor Co. (2) Monroe, Mich. (1) and (3) 59 S. Macomb St., Monroe, Mich. A. S. M. E., S. A. E.

O'CONNOR, Joseph, '07. 1st Nat. Bank Bldg., Oswego, N. Y.

ODDIE, Clarence Meigs, '99. Mills Bldg., San Francisco, Cal.

ODELL, Howard Bailey, M.E., '02. Packard Twin Six Agent. Beach Tree St., Atlanta, Ga.

ODELL, Jay B., M.E., '04. Western Elec. Co. Salesman. New York City.

OHEND'HAL, C. J., M.E., '07. U. S. R. C. S. Key West, Fla.

ODEND'HAL, Emile Sebastian, '04. Oakdale Ave., Baltimore, Md.

OFFINGER, Martin H., M.E., '99. Sec. and Treas., Van Wagoner Const. (2) and (3) 1133 Broadway, New York City. (1) 129 Third Ave., Pelham, N. Y.

OFFUTT, Mitchem Webb, '03. 32 W. 40 St., New York, N. Y.

OGDEN, Herbert G., M.E., '97. Lawyer. Patent. (2) and (3) 120 Broadway, New York, N. Y. (1) Fortland Farm, Stamford, Conn.

OGDEN, Warner Greene, M.E., '01. Patent Lawyer, partner of Phillips, Van Everen & Fish. (2) and (3) 53 State St., Boston, Mass. (1) 162 Monroe Road, Quincy, Mass. Engrgs. Club, Boston.

OGLE, John Howard, M.E., '00. C. Univ. Club, Los Angeles, Cal.

OGREN, Carl Francis, M.E., '17. 1344 Pacific St., Brooklyn, N. Y. A. S. M. E.

OHMER, John F., jr., M.E.,'13. Sales Eng. (2) Ohmar Fare Register Co., Dayton, O. (1) and (3) 354 West First St., Dayton, O. A. S. M. E., Jr.

OKADA, Heita, '96. Address not known.

O'KEEFE, John Eugene, M.E., '98. Cassil Pl., Carthage, Mo.

OLD, Clayton Woodman, '95. Montclair, N. J.

OLDBERG, Virgil, M.E., '02. (2) and (3) Pres. Oldberg Mfg. Co., 76-86 Forest Ave. E., Detroit, Mich. (1) 367 Wanterey Ave., Highland Park, Mich.

OLDS, Donald Smith, M.E., '11. Chief Draftsman, Concrete Dept. (2) Lansing Co., Lansing, Mich. (1) 215 N. Chestnut St., Lansing, Mich. (3) P. O. Box 326, Lansing, Mich.

O'LEARY, John William, M.E., '99. (2) and (3) Sec. and Treas. Arthur J. O'Leary & Son Co., Clearing Post Office, Chicago, Ill. (1) 4013 Drexel Boul., Chicago, Ill.

OLIN, Franklin Walter, jr., M.E.,' 12. 1128 State St., Alton, Ill.

OLIN, Fred C., '84. 91 Livingston St., Buffalo, N. Y.

OLIN, R. N., '16. 10 Lock St., Buffalo, N. Y.

OLIPHANT, Donald Creigh, M.E., '11. 156 W. State St., Trenton, N. J.

OLIPHANT, James Norris, M.E., '01. 61 Broadway, New York, N. Y.

OLIPHANT, John, '96. Grace Church Rectory, Carthage, Mo.

OLIVER, Albert Ray, M.E., '11. Plant Supt., Riverdale Plant., U. P. & L. Co. Ogden, Utah.

OLIVER, Clifford Rylander, M.E., '08. (2) and (3) Care New England Power Co., Worcester, Mass. (1) 16 Richmond Ave., Worcester, Mass.

OLIVER, Cyrus Golie, '92. Onawa, Iowa.

OLIVER, George Dow, '15. Telluride Association, Provo, Utah.

OLIVER, William Burton, '79. Address not known.

OLNEY, Edwin Lewis, '96. Care Rutland Garment Co., Rutland, Vt.

OLNEY, Raymond, M.E., '10. Editor *Power Farming, Gas Power.* St. Joseph, Mich. Amer. Soc. Agr. Engrs., Natl. Gas Eng. Ass.

OLSEN, Thorsten Yhlen, M.E., '03. 500 N. 12 St., Philadelphia, Pa.

O'NEIL, Fred Ernest, M.E., '07. Malone, N. Y.

OPPENHEIMER, Leo Adolph, M.E., '14. 318 Galiad St., San Antonio, Texas.

ORBISON, Thomas Eugene, M.E., '10. 699 Lawrence St., Appleton, Wis.

ORCUTT, Daniel Paul, M.E., '07. Engineering Salesman. (2) Elec. Storage Bat. Co., 100 Broadway, New York City. (1) and (3) 34 Webster Ave., Roselle Park, N. J. A. I. E. E., Elec. Vehicle Assn. of Amer.

ORLEMAN, Walter Florenzie, M.E., '98. Peekskill, N. Y.

ORNELAS, Ernesto, M.E., '15. Fort Plain, N. Y.

ORTEGA, Emilia Daniel, '03. Address not known.

ORTIZ DE ROZAS, Alfredo, '04. 51 N. 355 La Plata, Argentine Republic.

ORTON, Albert William, jr., M.E., '12. 107½ W. Thomas St., Rome, N. Y.

ORVIS, Warner Dayton, M.E., '07. Orvis Bros. & Co., Brokers. (2) and (3) 60 Broadway, New York City. (1) 645 West End Ave., New York City.

OSAME, Sanji, M.E., '01. 1 Chrome, Yamamoto-Dori, Kobe, Japan.

OSBORN, George, '91. Hamilton, N. Y.

OSBORN, Lewis James, '96. (2) and (3) Vice-Pres. and Gen. Mgr. Fairbanks Morse Elec. Mfg. Co., Indianapolis, Ind. (1) 3133 N. Pennsylvania St., Indianapolis, Ind.

OSBORNE, Curtis Ralph, M.E., '03. Engineer. Box 47, R. F. D. 8, Schenectady, N. Y. Ry. Motor Eng. Dept. Gen. Elec. Co., Schenectady N. Y.

OSBORNE, Loyall Allen, '02. 383 Park Ave., New York City.
OSGOOD, Albert Kendrick, '08. 113 N. Washington St., Herkimer, N. Y.
OSGOOD, Edgar Montague, '04. 5 Harrison Ave., Holyoke, Mass.
OSKAMP, Howard Earle, '07. Huntington, Ind.
OSTBY, Raymond Englehart, M.E., '06. 444 Brook St., Providence, R. I.
OSTERHOUT, William Earl, M.E., '17. 10 Maple Court, Brooklyn, N. Y.
OSTOS, José Antonio, M.E., '08. Heusteca Petroleum Co., Tampico, Mex.
OSWALD, Frederick Arthur, '97. Address not known.
OTHUS, James Carey, M.E., '17. 363 Rose St., Portland, Ore.
OTIS, G. Frank, B.M.E., '80. Retired. 560 Prescott St., Pasadena, Cal.
OTT, George Frederick, jr., '04. 207 Buttonwood St., Philadelphia, Pa.
OTT, Oran Whitman, M.E., '03. 1001 Kearns Bldg., Salt Lake City, Utah.
OTT, Paul Montague, '95. 50 Church St., New York City.
OTTERSON, Henry A., M.E., '97. Ridgway Dynamo & Engine Co., Ridgway, Pa.
OTTERSON, Nelson Easton, M.E., '99. 575 Mills Bldg., San Francisco, Cal.
OTTO, Henry S., '07. Treasurer (Importing and Exporting). Scarsdale, N. Y. A. S. M. E., S. A. E.
OUTERBRIDGE, Franklin, B.M.E., '77. Hamilton Parish, Bermuda.
OUTES, Enrique Sixta, M.E., '13. 971 Albarado St., Salta, Arg. Rep., S.A.
OVEROCKER, Randall Hayner, M.E., '11. Engrg. Assistant, N. Y. Tel. Co. (2) and (3) 15 Dey St., New York City. (1) Hasbrouck Hts., N. J. A. I. E. E.
OVERTON, Frederic Stanley, Sp. M., '01. 91 Rockview Ave., Plainfield, N. J.
OVIATT, David B., M.E., '87. Asst. Engr., Bd. of Water Supply, New York City. 172 W. 109th St., New York City. A. S. M. E.
OWEN, Arthur Stephen, M.E., '10. Monticello, N. Y.
OWEN, Charles Hundley, M.E., '07. Warner & Swasey Co., Cleveland, O.
OWEN, Ira June, M.E., '03. 105 S. La Salle St., Chicago, Ill.
OWENS, Harold Van Dyke, C.E., '05. 127 Thomas St., Utica, N. Y.
PACKARD, Warren, M.E., '14. Private Secretary to Mr. W. D. Packard. Warren, Ohio.
PACKER, Samuel Henry, '13. 302 E. Union St., Burlington, N. J.
PADDOCK, John Baker, '74. Weather Bureau, 318 Front St., Grants' Pass, Ore.
PADDOCK, Ormond Howland, M.E., '07. 29 Produce Exch., Toledo, O.
PAETOW, Herman Ernest, jr., M.E., '12. Goodyear Tire & Rubber Co., Bowmanville, Ont., Can.
PAGE, Charles Locke, '97. 450 5th Ave., West Allis, Wis.
PAGE, Edwin, '05. 507 Rookery Bldg., Chicago, Ill.
PAGE, George Bailey, M.E., '11. (1) 920 Cartnet Ave., Trenton, N. J. (2) and (3) Care De Laval Steam Turbine Co., Trenton, N. J.
PAGE, Kenneth Andrew, '08. Care Wheeling Electric Co., Moundsville, W. Va.
PAGE, Louis French, '04. 743 S. Main St., Athens, Pa.
PAGE, Roy, '04. Care Putnam Page Co., Peoria, Ill.
PAGE, William Tracy, '96. Address not known.
PAGE, Wilsen K., M.E., '09. Elect. Eng., W. N. Y. & P. Trac. Co., Olean, N. Y. A. I. E. E.
PAINE, Henry Ellsworth, M.E., '06. 440 Market St., San Francisco, Cal.
PAINE, William Nettleton, '13. Accountant. (2) and (3) Northern Pacific Ry. Co., Spokane, Wash. (1) 2509 Mission Ave., Spokane, Wash.
PALE, Frederick Gilbert, M.E., '17. 4 Lincoln St., New Rochelle, N. Y.
PALEN, Charles Beakes, M.E., '13. Rockland, N. Y.
PALEN, Frederick Pomeroy, M.E., '94. Vice-Pres. Newport News Shipbuilding Dry Dock Co. (2) and (3) 233 Broadway, New York City. (1) 131 Riverside Drive, New York City. A. S. N. E., and A. S. N. A., and M. E.
PALMER, D. O., M.E., '13. 60 Parker Ave., Buffalo, N. Y.
PALMER, Everett Arthur, '09. (2) American Broke Shoe and Foundry Co., 30 Church St., New York City. (1) and (3) 762 Newark Ave., Elizabeth, N. J. A. I. E. E., A. E. R. A., N. Y. R. R. Club.
PALMER, Eugene Preston, jr., '04. Address not known.
PALMER, Harry Mitchell, M.E., '92. 71 Hazlewood Ave., Pittsburg, Pa.
PALMER, Henry Oliver, M.E., '07. 789 S. Main St., Geneva, N. Y.
PALMER, Herbert Rodman, M.E., '87. 8903 Cedar Ave., Cleveland, O.
PALMER, Rafael Maria, M.E., '12. Care Giorgetti, Cintron, Abay & Co., San Juan, P. R.
PALMER, Stanley Gustavus, M.E., '10. 203 Mill St., Reno, Nev.
PALMITER, Clebron Wood, M.E., '14. 128 Winthrop St., Watertown, N. Y.
PANGBORN, Robert Garrett, M.E., '08. 1310 N. Charles St., Baltimore, Md.
PAPAZIA, Hapet, M.E., '15. (1) Bekek, Constantinople, Turkey. (2) and (3) 28 Linden Rd., Bournville, Birmingham, Eng.
PAPPENHEIMER, Ralph, M.E., '12. Treas. and Off. Mgr., The Specialty Device Co. (2) and (3) 112 W. 3d, Cincinnati, O. (1) 12322 Upland Pl., Cincinnati, O.
PARCE, Donald H., M.E., '09. Vice-Pres. and Sec., Manhattan Foundry Co. (2) and (3) 1812 Dwight Way, Berkeley, Cal. (1) 5820 Ocean View Drive, Oakland, Cal.
PARET, John, jr., '93. Union Trust Co., 80 Broadway, New York City.
PARK, Arthur Bushnell, '92. Engr., 201 W. 13 St., New York City.
PARKE, Frederic Huntington, '92. 318 Westinghouse Bldg., Pittsburg, Pa.
PARKE, Robert Augustus, B.M.E., '79, B.C.E., '80. 1901 Fremont Ave., Minneapolis, Minn.
PARKE, Richard Averill, M.E., '17. 1901 Freemont Ave. S., Minneapolis, Minn.
PARKER, Benjamin Franklin, M.E., '98. Address not known.
PARKER, Earle Daniel, M.E., '01. (1) 1719 Camp Ave., Rockford, Ill. (2) and (3) Barber-Colman Co., Rockford, Ill. S. A. E
PARKER, Francis Warner, jr., '11. 198 Glenwood Ave., Hubbard Woods, Ill.
PARKER, James Wentworth, M.E., '08. Supt. Central Heating Cos., Asst. Chief Engr. of Power Plants. (2) The Detroit Edison Co., Detroit, Mich. (3) and (1) 301 Lawrence Ave., Detroit, Mich. A. S. M. E., Detroit Engrg. Club.
PARKER, Lee Hamilton, M.E., '89. President Spray Engrg. Co., (2) and (3) 93 Federal St., Boston, Mass. (1) 72 Englewood Ave., Brookline, Mass. A. I. E. E., A. S. M. E., N. E. St. Ry. Club, Amer. El. Ry. Assn., Boston Engrgs. Club.
PARKER, MacRea, M.E., '14. Supr. Mech. Equip., Bell Tel. Co. of Pa. (2) 13th and Arch Sts., Philadelphia, Pa. (3) W. B. Y. M. C. A., 52d and Sansom Sts., Philadelphia, Pa. (1) 1832 Ontario Pl., Washington, D. C.
PARKER, Roscoe Conkling, '08. Perry, N. Y.
PARKHILL, Mortimer Smith, M.E., '17. 390 Main St., Poughkeepsie, N. Y.
PARKIN, Grenville, W., M.E., '11. Inspector and Draughtsman. (2) L. V. R. R., 143 Liberty St., New York City. (1) and (3) Bound Brook, N. Y.
PARMLEY, Harry Mark, '07. Instructor, Cornell Univ. (2) and (3) Ithaca, N. Y. (1) 507 N. Aurora St., Ithaca, N. Y.
PARMELEE, Clifford Hunt, M.E., '13. 7 Arcade St., Saratoga, N. Y.
PARNALL, William Edward, jr., '95. Address not known.
PARRISH, Justin E., jr., '08. 839 Clay Ave., Scranton, Pa.
PARSONS, George, A.B., '02, M.E., '04. Winnebago, Ill.
PARSONS, Harold Livingston, '10. 213 Main St., Penn Yan, N. Y.
PARSONS, Wilber Hayden, '04. Address not known.
PARTRIDGE, A. L., M.E., '13. 5188 Cabanne St., St. Louis, Mo.
PARTRIDGE, Alonzo Hammond, M.E., '99. 96 E. Chester St., Kingston, Pa.
PASSMORE, John Faxon, M.E., '14. (2) and (3) Care Joseph Bancroft & Sons Co., Wilmington, Del. (1) 919 Gilpin Ave., Wilmington, Del.
PATE, Carl Overton, '00. Insurance Broker. (2) and (3) 100 William St., New York, N. Y. (1) 117 W. 75 St., New York City.
PATTERSON, Earle Vincent, M.E., '12. 520 Plymouth Ave., Rochester, N. Y.
PATTERSON, F. Gordon, '00. 26 Cedar St., Boston, Mass.
PATTERSON, Gus Harold, '07. 633 Marion Ave., Mansfield, O.
PATTERSON, Howard Charles, jr., '07. Care Fairbanks, Morse & Co., New Orleans, La.
PATTERSON, John Johnston, '02. 431 Dearborn St., Chicago, Ill.
PATTERSON, Lucius Lamar, M.E., '06. Prof. Electrical Engrg., Agricultural College, Mississippi. (1) (2) and (3) Mississippi A. & M. College. S. P. E. E.
PATTERSON, Stephen Hoyt, '02. Sec. Bridgeport Patent Leather Mfg. Co. 851 Clinton Ave., Bridgeport, Conn.
PATTERSON, Webster, M.E., '86. Lawyer. Elko, Nev.
PATTISON, Roy Stuart, M.E., '05. Engineer. (2) and (3) Holzer Cabot Elec. Co., Boston, Mass. (1) 30 Hemenway St., Boston, Mass. A. I. E. E. Soc.
PATTON, William Fearn, jr., M.E., '06. 403 Gray Apts., Wilkinsburg, Pa.
PAULES, Parvin Elwood, M.E., '15. 2 Walnut St., Danville, Pa.
PAULLIN, Carl Alfred, M.E., '13. Machine Designer. (2) National Cash Register Co., Dayton, Ohio. (1) and (3) Y. M. C. A., Dayton, O. Dayton Engrs. Club.
PAYNE, Edward Duggan, M.E., '07. 1016 Monadnock Bldg., Chicago, Ill.
PAYNE, Olcott, '94. 307 Park Bldg., Cleveland, O.
PAYNE, William Johnson, '02. Address not known.
PEAKE, G. M., M.E., '14. Delhi, N. Y.
PEAKE, Lawrence Joseph, M.E., '11. Care Gould Mfg. Co., St. Louis, Mo.
PEARCE, Frederick Kinsley, M.E., '08. 59 26 St., Elmhurst, L. I.
PEARCE, George Clifford, '09. Address not known.
PEARCE, Walter Chandler, M.E., '97. Supt. Syracuse Lighting Co. (2) 335 S. Warren St., Syracuse, N. Y. (1) 465 Allen St., Syracuse, N. Y. Tau Beta Pi, A. I. E. E., N. E. L. A.
PEARSALL, George Martin, M.E., '15. 86 Woodruff Ave., Brooklyn, N. Y.
PEASE, Harold Childs, M.E., '97. 1413 Union St., Schenectady, N. Y.
PEASE, Harry W., M.E., '09. Engineer Elec. R. R. (2) New York State Railways, Syracuse, N. Y. (1) 274 Holland St., Syracuse, N. Y. A. E. R. A.
PEAVEY, Harris Booge, M.E., '07. (1) and (2) 37 Clinton Ave., Maplewood, N. J.
PECK, Allen John, M.E., '04. Address not known.
PECK, Harry Gold, '93. 77 Herkimer St., Brooklyn, N. Y.
PECK, Henry W., M.E., '00. Vice-Pres. and Gen. Mgr., Schenectady Ill. Co., Mohawk Gas Co. (2) and (3) Care Schen. Ill. Co., 511 State St., Schenectady, N. Y. (1) 32 Waverley Place, Schenectady, N. Y. A. I. E. E., A. S. M. E., A. G. I., N. C. G. A., N. L. L. A.
PECK, John Sedgwick, M.E., '92. Cons. Engr., British West. E. & M. Co. (2) and (3) Trafford Pk., Manchester, Eng. (1) Schenley, Bentick Rd., Altruecham, Eng. A. I. E. E., T. E. E. (Br.), A. S. A. S., Manchester Assoc., Engrs.
PECK, Percival Starr, M.E., '08. Hotel Willard, Butler, Pa.
PECK, Ross Saunders, M.E., '05. Care Westinghouse, Church, Kerr & Co., New York City. Asst. Engr., Power Plant Design and Construc.
PECK, William Henry, '89. 282 Convent Ave., New York City.
PEEBLES, Herbert Kenneth, M.E., '16. 81 E. Utica St., Oswego, N. Y.
PEEBLES, James Clinton, M.M.E., '08. Care Armour Institute of Technology, Chicago, Ill.
PEFLEY, Harlen, M.E., '17. Boise, Idaho.
PEIRCE, Clarence Arthur, M.E., '09, A.B., '07. Asst. Prof. M. E., Sibley College, Cornell University. (1) 109 College Ave., Ithaca, N. Y.
PENCE, D. W., M.E., '18. 155 Fort "W." Detroit, Mich.
PENDLETON, Frank Ellsworth, M.E., '01. 140 Cedar St., New York, N. Y.
PENNEY, Albert Silas, M.E., '02. Sec. Treas. Keystone Appraisal Co. (2) 331 Walnut St., Philadelphia, Pa. (1) and (3) 41 Cornell Ave., Yonkers, N. Y.
PENNEY, Harold F., M.E., '10. Instructor in charge, Continuation School for Machinist Apprentices and Helpers. (1) 39 Vineland Terrace. (3) and (2) Pratt & Whitney Co., Hartford, Conn.
PENNINGTON, John '14. Address not known.
PENNINGTON, Victor Power, M.E., B.S., '17. Millington, Md.
PENNOCK, Theodore Eddy, '10. 1820 E. Genesee St., Syracuse, N. Y.
PENWELL, Clyde Chamberlain, M.E., '10. Address not known.
PERCY, Lee Johnston, '14. 459 Oakwood Blvd., Chicago, Ill.
PEREZ, José Raul, M.E., '14. Calle 9 Na 44, Vedado, Havana, Cuba.
PERKINS, Frank Clinton, M.E., '91. Erie City Bank Bldg., Buffalo, N. Y.
PERKINS, Fred Clarck, M.E., '01. Pres. Perkins Elec. Co. (2) 310 1st Ave., S. Seattle, Wash. (1) and (3) 4717 Brooklyn Ave., S. Seattle, Wash.
PERKINS, George Clarence, '93. 17 High St., Newark, N. J.
PERKINS, Harold Charles, M.E., '15. 156 W. 3d St., Fulton, N. Y.
PERKINS, Laurence Merton, M.E., '15. Care Westinghouse Co., Pittsburgh, Pa.
PERRY, Charles Frederick, M.E., '04. 331 Virginia St., Milwaukee, Wis.
PERRY, George Templeton, '13. 1605 Washington Ave., St. Louis, Mo. (3) 5355 Vernon Ave., St. Louis, Mo.
PERRY, Leslie Donald, M.E., '07. Comptroller, Central Iron & Steel Co. 2139 Green St., Harrisburg, Pa. Eng. Soc. Penn.
PERRY, Samuel Brown, M.E., '94. 1 Liberty St., New York, N. Y.
PERRY, William Talbot, '99. Address not known.
PERTSCH, John George, jr., M.E., '09. Asst. Prof. in Elec. Engrg. (2) and (3) Franklin Hall, Cornell Univ., Ithaca, N. Y. (1) 315 College Ave., Ithaca, N. Y. A. I. E. E., Sigma Xi, H. K. N.
PESANT, Charles Alfonso, M.E., '13. Engr. Krajewski Pesant Corporation, Havana, Cuba. (3) Havana Iron Works, Regla, Havana, Cuba. *Office* Vedado, Havana, Cuba.
PETERS, Heber Cushing, M.E., '92. Mech. Engr. (2) and (3) 2262 Woolworth Bldg., New York City. (1) 39-41 Claremont Ave., Apt. 112, New York City.
PETERSON, Amos Gale, M.E., '09. 409 Elmwood Ave., Buffalo, N. Y.
PETERSON, C. Gilbert, M.E., '06. Mech. Engineer. (2) and (3) Griscom Russell Co., 90 West St., New York City. (1) 453 Market St., Lockport, N. Y.

PETERSON, EUGENE, '15. Address not known.
PETERSON, ERNEST LOUIS, M.E., '10. Supt. Machine Shops and Fd. Clearfield Machine Shop. 502 New St., Clearfield, Pa.
PETERSON, WALKER FAIRFIELD, M.E., '11. (2) Milwaukee Elec. Ry. & Lt. Co., Milwaukee, Wis. (1) and (3) Wheeling, W. Va. A. E. R. A.
PETICOLAS, SHERMAN GOODWIN, '93. Consulting Elec. and Mech. Engr. (1) 5002 Dodge St., Omaha, Neb. (2) and (3) 405 Brandeis Theatre Bldg., Omaha, Neb. A. I. E. E.
PETIT, RAYMOND AUGUST, '07. Asst. Treas., The Phoenix Couster, Co. (2) and (3) Room 203-133 S. West Temple St., Salt Lake City, Utah. (1) 416 E. South Temple St., Salt Lake City, Utah.
PETRIE, SAMUEL LEYS, '09. 107 Lincoln Ave., N. Tonawanda, N. Y.
PETTERSEN, OSCAR GIDEON, M.E., '15. 21 Edward St., Worcester, Mass.
PETTENGILL, BENJAMIN MILLER, M.E., '00. Mfg. of Apple Products, Holley, N. Y.
PETTIT, IRVING C., M.E., '03. Engr. West. Elec. Co. (2) 463 West St., New York City. (1) and (3) 506 Hudson Ave., Weehauken, N. J. Tel. Soc. of N. Y., A. A. A. S., A. I. E. E.
PETTIT, KARL DRAVO, M.E., '12. 708 Ocean Ave., Flatbush, Brooklyn, N. Y.
PEW, JOSEPH NEWTON, JR., M.E., '08. Morris Bldg., Philadelphia, Pa.
PFAU, ELLWOOD THORNE, M.E., '12. (1) and (3) 219 S. D St., Hamilton, O.
PFAU, MACBETH BAYARD, M.E., '10. 219 S. D St., Hamilton, O.
PHARR, EUGENE ALBERTUS, M.E., '01. Morgan City, La.
PHELAN, ROBERT EARLY, '10. 1303 F St., Washington, D. C.
PHELAN, JAMES, M.E., '09. 501 Union Ave., Memphis, Tenn.
PHELON, JOSEPH OLIVER, M.M.E., '01. Prof. Elec. Eng. (2) Wor. Polytech. Institute, Worcester, Mass. (1) 27 Schussler Rd., Worcester, Mass. A. I. E. E., Sigma Xi.
PHELPS, HARRY PERRY, M.E., '09. 33 St. and West Ave., Newport News, Va.
PHILBRICK, FRANK HERBERT, M.E., '07. Chicago Manager, Midvale Steel Co. (2) and (3) 845 Ry. Exchange Bldg., Chicago, Ill. (1) 78 South Beacon St., Hartford, Conn.
PHILIPS, JOSEPH BOND, M.E., '06. (2) and (3) Amer. Mica Co., Newton Lower Falls, Mass. (1) The Lyman, Wellesley Hills, Mass.
PHILIPPI, CARL AUGUST, M.E., '15. Engrg. West E. & M. Co. (2) Newark, N. J. (1) and (3) 16 Bennett St., Leonardo, N. J.
PHILLIPS, ARTHUR MORTON, M.E., '04. 1210 Granite Bldg., Rochester, N. Y.
PHILLIPS, EVERETT ALFONSO, M.E., '10. Beach Haven, N. J.
PHILLIPS, ELLIS LAURIMORE, M.E., '95. 50 Church St., New York, N. Y.
PHILLIPS, GEORGE HENRY, '77. 141 Lincoln Ave., Newark, N. J.
PHILLIPS, HAROLD BRADEY, '11. (1) 2343 Military St., Port Huron, Mich. (2) and (3) Care Cutler Hammer Co., Chicago, Ill.
PHILLIPS, HENRY ORMSBY, '07. (1) 459 Bellefontaine St., Pasadena, Cal. (2) and (3) 603 Central Bldg., Pasadena, Cal.
PHILLIPS, LEON REDNER, M.E., '12. Mech. Eng. Const., Dept. Swift & Co. 64 N. Market St., Boston, Mass.
PHILLIPS, MILTON JONATHON, M.E., '03. R. F. D. 3, E. Bloomfield, N. Y.
PHILLIPS, WENDELL EDGAR, M.E., '14. Christian Assoc., Rutgers College, New Brunswick, N. J.
PHILLIPS, WOODLEY GAIL, '04. Chelsea, Oklahoma.
PHILLIPS, WILLIAM HOPESTILL, M.E., '12. R. D. Nuttall Co., Pittsburg, Pa.
PHILLIPS, SAMUEL MCLURE, '11. 438 E. State St., Sharon, Pa.
PHILIPPI, CARL AUGUST, M.E., '15. Leonarda, N. J.
PHILBRICK, ALEN EDGAR, '02. 827 Ry. Exch. Bldg., Chicago, Ill.
PHILLIPS, VICTOR BOURN, M.E., '15. 730 Leader Bldg., Cleveland, Ohio.
PHINNY, CHARLES MAYHEW, JR., '14. 1246 Dean St., Brooklyn, N. Y.
PHISTERER, FREDERICK WILLIAM, M.E., '95, M.M.E., '96. Fort Roger, Oahu, Hawaii.
PHRANER, W. W., M.E., '13. 31 Lenox Ave., East Orange, N. J.
PICOTTE, HARRY TAYLOR, '99. Hailey, Idaho.
PICKSLAY, WILLIAM WALTON, M.E., '15. 155 Main St., Bethlehem, Pa.
PICCARD, JULES EUGENE, '15. 1233 Fulton St., Brooklyn, N. Y.
PIEDBOUEF, ADRIEN GUSTAVE, '03. 17 Bismark St., Dusseldorf, Germany.
PIEL, ALFRED LUDWIG, '04. 3138 N. Meridian St., Indianapolis, Ind.
PIEL, ELMER WILLIAM, '04. 3138 N. Meridian St., Indianapolis, Ind.
PIERCE, EDWIN HALL, '92. Organist, Composer, Writer on musical topics. (2) 16 Seminary St., Auburn, N. Y. (1) 2 Wheeler St., Auburn, N. Y. Amer. Guild of Organists, Amer. Federation of Musicians.
PIERCE, FRANK WALLACE, '04. Sharpsville, N. Y.
PIERCE, FRANK W., M.E., '16. (2) and (3) Care Goodyear Tire & Rubber Co., Akron, O. (1) 717 Eagle St., Dunkirk, N. Y. Tau Beta Pi.
PIERCE, HOMER JAY, M.E., '09. 102 W. 35th St., Minneapolis, Minn.
PIERCE, HOWARD CASTNER, B.S. in Agr., '07. 1838 Chestnut St., Philadelphia, Pa.
PIERCE, JONAS JAMES, '95. Sharpsville, Pa.
PIERSON, ELVIN LYLE, M.E., '17. Trumansburg, N. Y.
PIERCE, RALPH EDWIN, M.E., '13. Elec. Engr. (1) 44 Stuyvesant Ave., Larchmont, N. Y. (2) and (3) Eng. Dept. A. T. & T. Co., 195 Broadway, New York City.
PIERCE, WILLIAM EDWARD, M.E., '06. 910 Commonwealth Ave., Brookline, Mass.
PIERSON, HAROD CHAMBERLAIN, '11. 16 Maurice Ave., Ossining, N. Y.
PILCHER, JOHN ALSOP, '92. 1025 Henry St., S. W., Roanoke, Va.
PILLMORE, FRED, M.E., '92. 345 Bryant Ave., Syracuse, N. Y.
PIMPER, THEODORE FREDERICK, M.E., '10. Harron, Richard & McCone, San Francisco, Cal.
PINCKARD, RYBURN, '05. 930 S. 20 St., Birmingham, Ala.
PINGER, GEORGE CHRISTIAN, '05. (1) 65 Park Ave., New York City. (2) and (3) 47 West St., New York, N. Y.
PINNEY, H., M.E., '15. Care Otis & Co., 215 Cayahoya Bldg., Cleveland, O.
PINNER, SEYMOUR WILLIAM, M.E., '08. Address not known.
PIPER, CLARENCE BRETT, LL.B., '05. 148 Grain Exch., Winnipeg, Man., Canada.
PIPER, JOHN STRYKER, '09. 38 Point St., Yonkers, N. Y.
PISER, THEO. H., M.E., '95. Mgr. and Treas. Welsbach Co. of N. E. (2) and (3) 16 Oliver St., Boston, Mass. (1) 155 Moffat Road, Waban, Mass. Ill. Eng. Soc., Am. Gas Inst., N. E. Ass. Gas Engrs., Nat. Comm. Gas Assn.
PITCAIRN, ROBERT, '03. Pitts. Plate Glass Co., Tarentum, Pa.
PLACE, EARLE GERALD, M.E., '11. 16 Elm St., Oneonta, N. Y.
PLACE, EDWIN, M.E., '94. Elec. Engr. (2) Gen. Elec. Co., Schenectady. (1) and (3) 101 Hight St., Schenectady, N. Y.
PLACK, LOUIS, JR., '91. Altoona, Pa.
PLATE, THEODORE G., JR., M.E., '96. Optometrist Jeweler. (2) and (3) Church St., Hackettstown, N. J. (1) 162 Main St., Hackettstown, N. J.
PLATT, FREDERICK JOSEPH, M.E., '92. 827 Clay Ave., Scranton, Pa.
PLATT, HUGH MALCOLM, M.E., '11. (1) 916 E. State St., Ithaca, N. Y. (2) and (3) 239 W. 39 St., New York, N. Y. New York Railroad Club.
PLAYER, PRESTON, '03. 15 State St., Boston, Mass.
PFEIFFER, EDWARD PHILIP, M.E., '82. Address not known.
PLUMB, HAROLD BLAIR, M.E., '01. Iowa Dairy Sep. Co., Waterloo, Iowa.
PLUMB, MAURICE WILLIAM, M.E., '09. Mgrg. Engr. Pneumatic Concrete Placing Co. of Canada. (1) 48 Second St., Malone, N. Y. (2) and (3) 120 St. James St., Montreal, Can. A. I. E. E., C. S. C. E., A. A. A. S.
PLUNKETT, CLARENCE EDWARD, '17. 213 Elm St., Rome, N. Y.
POATE, FREDERICK WILLIAM, M.E., '05. Bisley, Surrey, England. 2d Lt. in Motor Machine Gun Service.
POLLARD, GURDON TYLER, '03. Instr. Industrial Dept., Centennial High School. (2) and (3) Pueblo, Colo. (1) 2111 Greenweed, Pueblo, Colo.
POLLARD, SEABURY GOULD, M.E., '91. Conslt. Engr., Water Supply. 3422 Burch Ave., Cincinnati, O. A. S. M. E., A. W. W. Ass., N. E. W. W. Assn.
POLSON, ALEXANDER VIVIAN, M.E., A.B., '17. (1) 94 Cathedral St., Winnipeg, Man., Canada. (2) and (3) Goulds Mfg. Co., Seneca Falls, N. Y. A. I. E. E.
POMEROY, FRED LAWRENCE, M.E., '03. Chief Clerk, Tariff Bureau, N. Y. C. R. R. (2) and (3) 2416 Grand Central Terminal, New York City (1) 513 8th Ave., Brooklyn, N. Y.
POMEROY, HARRY DWIGHT, '90. 134 Baker Ave., Syracuse, N. Y.
POMEROY, WILLIAM DUTTON, M.E., '96. Vice-Pres. and Genl Mgr. (2) and (3) The Goulds Mfg. Co., Seneca Falls, N. Y. A. S. M. E., A. I. E. E.
POND, GEORGE FRANKLIN, M.E., '10. (1) 515 Barry Ave., Chicago, Ill. (2) and (3) 1001 Federal Life Bldg., Chicago, Ill.
POND, HENRY OTIS, M.E., '96. Timber-Pulp and water power properties. Care E. B. Cadwell & Co., Inc., 25 Broad St., New York City. (1) Tenafly, N. J. Am. Soc. Mech. Eng., A. S. C. E.
POPE, CHAS. EDWARD, '91. Mech. Engr., 611 New England Bldg., Cleveland, Ohio.
POPE, CLARENCE JAMES, M.E., '11. (1) 23 Ely Place, East Orange, N. J. (2) and (3) Arlington Co., Arlington, N. J.
POPE, GEORGE WHITNEY, '98. 725 Citizens Bldg., Cleveland, Ohio.
POPE, SAMUEL AUSTIN, M.E., '14. Contracting. (1) 1120 Ontario St., Oak Park, Ill. (2) and (3) 26 N. Jefferson St., Chicago, Ill.
POPE, WILLIAM GEORGE, '11. Holcomb, N. Y.
POPP, WALTER HENRY, '15. Patent Attorney, Geyser & Popp. (1) 60 Tillinghast Place, Buffalo, N. Y. (2) and (3) 619 Brisbane Bldg., Buffalo, N. Y. A. S. M. E., Buffalo Engrg. Soc., Aero Club. A. S. M. E.
DE PORRATA-DORIA, LUIS ANGEL, M.E., '14. Calle Comercio, Ponce, P. R.
PORTER, ARTHUR ROGERS, '04. Hotel Del Prado, Chicago, Ill.
PORTER, BRAYTON ATWATER, M.E., '13. (1) 10 Lake Court, New Britain, Conn. (2) and (3) New Britain Machine Co., Salesman, New Britain,
PORTER, GEORGE, JR., M.E., '97. (2) and (3) Uniontown, Pa. (1) 108 Morgantown St., Uniontown, Pa. A. S. M. E.
PORTER, HARRY FRANKLIN, 5 N. Wabash St., Chicago, Ill.
PORTER, HENRY J., M.E., '05. Engrg. Asst., Tel. Engr. (2) 15 Dey St., N. Y. Tel. Co., New York City. (1) and (3) 133 Park St., Montclair, N. J. N. Y. Tel. Soc.
PORTER, HENRY WHITTIER, M.E., '17. 126 Longwood Ave., Brookline, Mass. Tau Beta Pi.
PORTER, LA FAYETTE LE VAN, M.E., '12. (2) and (3) Standard Oil Co., Karachi, India. (1) 101 Waverly Place, New York City.
PORTER, WILLIAM SHERWOOD, M.E., '97. Mfgr. Auto parts. (2) and (3) 1526 S. Wabash Ave., Chicago, Ill. Chicago Auto Club.
POST, GEORGE ADAMS, JR., M.E., '05. (1) 4908 Sheridan Rd., Chicago, Ill. (2) and (3) 1005 Peoples Gas Bldg., Chicago, Ill.
POST, RONALD WILLIS, M.E., '11. Mountain Lakes, N. J.
POSTEL, FRITZ ANDREW, M.E., '08. Light House Serv., Tompkinsville, N. Y.
POTOSKY, WALTER DAVID, M.E., '04. (1) 327 Central Park W., New York N. Y. (2) and (3) Metropolitan Elec. Mfg. Co., Long Island City, N. Y.
POTTER, DANIEL FREDERICK, JR., M.E., '16. Apparatus Sales Dept., Robertson-Cataract Co. (2) S. Elmwood Ave., Buffalo, N. Y. (1) and (3) 485 Auburn Ave., Buffalo, N. Y. Tau Beta Pi, A. K. M.
POTTER, FRANK HAMILTON, '13. (2) and (3) Care D. J. Desmond, 305 Underwood Bldg., San Francisco, Cal. (1) Hotel Marymount, O'Farrell and Jones Sts., San Francisco, Cal.
POTOSKY, WALTER DAVID, M.E., '04. Mech. Engr. (1) 327 Central Park, West, New York City. (2) and (3) Metropolitan Elec. Mfg. Co., Coney Island City, N. Y. N. Y. Elec. Soc.
POUCHES, ALLEN WARREN, M.E., '84. (2) and (3) Sec. State Normal School, Oswego, N. Y. (1) 169 W. Third St., Oswego, N. Y.
POUNSFORD, ARTHUR GRAHAM, M.E., '13. 5805 Belmont Ave., College Hill, Cincinnati, O.
PONST, HERBERT MILLARD, '13. 351 Wyoming Ave., Kingston, Pa.
POWELL, MILTON JEROME, M.E., '14. (1) and (3) 436 Convent Ave., New York, N. Y. (2) Care De La Vergne Machine Co., New York City.
POWELL, PERCY HOWARD, M.E., '95. 246 Vine St., Bridgeport, Conn.
POWELL, WILLIAM HENRY, M.E., '90, M.M.E., '01. (2) and (3) Allis Chalmers Co., Milwaukee, Wis. (1) 2508 Grand Ave., Milwaukee, Wis.
POWER, FRED S., M.E., '13. Asst. Supt., St. Paul Foundry Co., St. Paul, Minn. 751 Goodrich Ave., St. Paul, Minn.
POWERS, ALEXANDER MERRELL, M.E., '10. 154 6th Ave., Brooklyn, N. Y.
POWERS, RAY RIVINGTON, A.B., '07. Panama City, Fla.
POWERS, THOMAS BROWN, M.E., '15. (2) and (3) 8 Pine St., Glens Falls, N. Y. (1) 1510 West Ave., Richmond, Va.
POWLEY, EDWARD HARRISON, M.E., '02. 74 Chapel St., Albany, N. Y.
PRATHER, HARRY BILLINGS, '90. Consulting Engineer. (1) 2234 E. 80th St., Cleveland, O. (2) and (3) 662 Rockefeller Bldg., Cleveland, O. A. S. M. E., Cleveland Engrg. Soc.
PRATT, RALPH KING, M.E., '13. Eng. Paper Mills Dept. (2) and (3) Care Finch, Pruyn & Co., Glens Falls, N. Y. (1) 121 Bay St., Glens Falls, N. Y.
PRATT, REGINALD, '09. Cedarhurst, Long Island, N. Y.
PRATT, ROBERT RISDOM, '02. Address not known.
PRATT, RUSSELL BOYD, M.E., '14. 201 Chestnut St., Towanda, Pa.
PRATT, WARD ELY, M.E., '14. Heating Engr. and Furnace Salesman. (2) Sill Stove Wks., Rochester, N. Y. (1) and (3) 638 Plymouth Ave., Rochester, N. Y.
PRESCOTT, CURRY S., '11. Purchasing Agr., Prescott Co., Menominee, Mich. 312 Main St., Menominee, Mich.
PRESCOTT, FREDERICK MARS, '85. 609 Lake Drive, Milwaukee, Wis.
PREST, HAROLD MILLER, M.E., '13. Mech. Eng. (1) 5 Mosswood Ave., Orange, N. J. (2) Care Westinghouse, Church, Kerr & Co., 37 Wall St., New York City. A. S. M. E.
PRESTON, GEO. BURTON, M.E., '88, M.M.E., '97. Asst. Prof. of Steam Engr. Columbia University, New York City. Leonia, N. Y. A. S. M. E.
PRESTON, NEIL DE FOREST, M.E., '08. 1450 52 St., Brooklyn, N. Y.
PRESTON, SYLVESTER COSGROVE, M.E., '06. Peoples Nat. Gas. Co., Pittsburgh, Pa.
PRICE, LEWIS CAIRL, M.E., '11. 50 Church St., New York, N. Y.
PRICE, LUTHER EMMETT, M.E., '09. Pontotoc, Miss.
PRICE, PHILIP M., '07. 101 Main St., Johnstown, Pa.
PRICE, WILLIAM HERBERT, M.E., '04. (1) 310 S. Irving Ave., Chicago, Ill. (2) and (3) 304 Union Pacific, Headquarters Bldg., Omaha, Neb. A.I.E.E.
PRICE, WILLIAM TUDOR, M.E., '06. 129 Sickels Ave., New Rochelle, N. Y.
PRINCE, JOHN WALTER, M.E., '99, M.M.E., '15. 1012 Baltimore Ave., Kansas City, Mo.
PRITCHARD, JOHN FRANKLIN, M.E., '13. 540 N. 8th St., Manitowoc, Wis.
PROCTER, ROBERT WILLIAM, M.E., '12. Cleveland Miniature Lamp Works of G. E. Co. (2) and (3) 1806 E. 45th St., Cleveland, O. (1) 20 Penrose Ave., E. C., Cleveland, O.

PROCTOR, Robert Videtto, M.E., '14. Traveling Salesman. (2) and (3) Concrete Steel Products Co., 7 Water St., Boston, Mass. 250 N. Heights Ave., Youngstown, O. (1) 40 High St., Springfield, Mass.
PROPHET, John Mayhew, jr., M.E., '10. Mfg. Food Production Glass and Tin. Mount Morris, N. Y.
PRUSSING, Harry Frederick, '09. Real Estate, Broker. (1) 911 Maple Ave., Evanston, Ill. (2) and (3) 1101 Stock Exchange Bldg., Chicago, Ill.
PRUSSING, Rudolph Ernest, M.E., '04. (1) 13 E. Division St., Chicago, Ill. (2) and (3) Marquette Bldg., Chicago, Ill.
PRUYN, Francis Lansing, M.E., '94. 290 Broadway, New York, N. Y.
PUJALS, Joseph Hill, '02. Anton Recio 22, Havana, Cuba.
PULLIN, Charles, '73. Dentist, Roseville Ave., Newark, N. J.
PURDY, Asa Robert, M.E., '15. Chase Natl. Bank of New York, New York City. 2217 Newkirk Ave., New York City.
PURDY, Frank Dyer, M.E., '96. 4569 Oakenwald Ave., Chicago, Ill.
PUTNAM, Joseph Franklin, M.E., '10. Asst. Prof. E. E., Cornell University, Ithaca, N. Y.
PUTNAM, Russell Benjamin, M.E., '01. Marine Corps, Washington, D. C.
QUACKENBUSH, Paul, M.E., '03. Supt. and Mgr. Herkimer, N. Y.
QUACKENBUSH, Seelye Munn, M.E., '14. 1064 Elmwood Ave., Buffalo, N. Y.
QUARLES, Teo. Randolph, '09. Address not known.
QUICK, Howard Ludlow, '03. 521 E. 19 St., Flatbush, Brooklyn, N. Y.
QUICK, Ray Lewis, M.E., '09. 426 W. Mill St., Ithaca, N. Y.
RAAB, George Henry, '09. Westmont St., Johnstown, Pa.
RADLEY, Walter Leeworthy, M.E., '08. Mech. Engr. Steam Eng. Dept. (1) R. F. D., No. 7, Albion, N. Y. (2) Lackawanna Steel Co., Buffalo, N. Y. (3) 247 Georgia St., Buffalo, N. Y.
RAE, George, M.E., '96. 44 Jefferson Ave., Brooklyn, N. Y.
RAICHLE, Frank Godfrey, M.E., '86. 403 Porter Ave., Buffalo, N. Y.
RAIDABAUGH, John Adam, M.E., '05. 514 C St., Sparrows Pt., Md.
RAINEY, Charles Thomas, '90. Address not known.
RAKESTRAW, Arthur Garwood, M.E., '99. 422 W Miner St., Westchester, Pa.
RALLY, Chas. German, M.E., '02. Commercial Elec. Salesman. (1) 22 Bedford Road, Schenectady, N. Y. (2) and (3) P. & M. Dept., Gen. Elec. Co., Schenectady, N. Y. Assn. of Iron and Steel Elec. Engrs.
RALPH, John Joseph, M.E., '09. 40 Flushing Ave., Jamaica, N. Y.
RALSTON, Louis Chapman, M.E., '96. Box 9, Route 9, Campbell, Santa Clara Co., Cal.
RALSTON, William Spencer, '94. 34 Penn Ave., Pittsburgh, Pa.
RAMAGE, Joseph Cowan, M.E., '90. (2) Care Southern Ry. Co., Alexandria, Va. (3) Box 233, Alexandria, Va.
RAMAGE, William Raymond, M.E., '17. 45 Lewis St., Auburn, N. Y. A. S. M. E.
RAMEY, Blaine B., M.E., '10. Engr., Westinghouse Elec. & Mfg. Co. (2) East Pittsburgh, Pa. (1) 702 20th St., N. W., Washington, D. C. (3) 710 Coal St., Wilkinsburgh, Pa. A. I. E. E., Tau Beta Pi.
RAMSDELL, Thomas Spencer, M.E., '03. Monument Mills, Housatonic, Mass.
RAMSEY, Charles Henry, M.E., '17. 86 Chestnut St., Albany, N. Y.
RAMSEY, Edmund Payton, '95. Engineer Corps, City of New York. (2) and (3) Municipal Bldg., Long Island City, N. Y. (1) 25 Willett St., Jamaica, N. Y.
RAMSEY, Joseph Henry, M.E., '05. (2) and (3) Supt. The Embossing Co., Albany, N. Y. (1) Univer. Club, Albany, N. Y.
RAND, Benj. G., '03. Sec.-Treas. Rand Co., North Tonawanda, N. Y.
RAND, Charles Edward, '97. Address not known.
RANDALL, Joseph Walber, '98. Merchant, 116 E. Upsal St., Philadelphia, Pa.
RANDALL, Leon, '14. 226 Main St., Corinth, N. Y.
RANDALL, William Vincent, jr., '10. Care Linscoll Motor Car Co., 163 Columbus Ave., Boston, Mass.
RANDOLPH, Frank Harrison, M.E., A.B., '17. 131 Main St., Rahway, N. J. Sigma Xi.
RANGEL, Manuel, '13. 1 Jarcierias St., Puebla, Mex.
RANKIN, Robert, M.E., '04. Care Geo. S. Rankin, 116 Schuyler Pl., Ithaca, N. Y.
RANSOM, Willard, M.E., '99. 721 Western Ave., Davenport, Ia.
RANSOM, Frederic Garfield, '04. Address not known.
RAPLEY, Wm. Batchelor, M.E., '08. Supt. Paper Mill, West Va. Pulp and Paper Co., Luke, Md.
RAPP, Rudolph Albert, '00. Address not known.
RASCH, Gustav Alexander, M.E., '15. Telephone Engineer. (1) 105 St. Johns Rd. (3) Roland Pk., Md. (2) 108 E. Lexington St., Baltimore, Md. A. I. E. E.
RASMASON, H. Lewis, Spec. M.E., '10. Dooly Bldg., Salt Lake City, Utah
RASSBACH, Erich Carl, M.E., '06. (1) Lindenalee 24 ivl, Charlottenburg, Westend, Germany. (2) and (3) 1207 B St., S. E., Washington, D. C.
RAPELLI, Oliver Luis Ricardo, '10. Tucuman, Argentine Republic, S. A.
RASTALL, Walter Henry, M.E., '04. Salesman, Worthington Pump and Machinery Corp. (2) and (3) 1504 First National Bank Bldg., Cincinnati, O. (1) 4319 Franklin Ave., Norwood, Ohio.
RATH, Walter Franklin, M.E., '05. 699 W. California St., Pasadena, Cal.
RATHBONE, Richmond Laurin, M.E., '98. 1114 Sweetland Bldg., Cleveland, O.
RATHBUN, Edward, '98. Rathbun-Jones Eng. Co., Toledo, O.
RATHBUN, George Jay, M.E., '95. Vice-Pres. and Ch. Engr., "The Rathbun Jones Engrg. Co." (2) and (3) Toledo, O. (1) 2447 Collingwood Ave., Toledo, O.
RATHBUN, Sherrill Slade, A.B., '09. Pratt Inst., Brooklyn, N. Y.
RATTLE, Paul Stewart, M.E., '05. Sales Dept., Worth Bros. Co. (2) and (3) 1218 3d Ave., (1) Salt Lake City, Utah. A. S. M. E.
RAIM, Edward Phelps, '77. Mine Owner, 328 E. 14 St., Oakland, Cal.
RAUSCH, Roswell Henry, M.E., '13. Engr., Bureau of Tests. (1) 405 Grant Ave., Plainfield, N. J. (2) and (3) International Paper Co., Glens Falls, N. Y.
RAWSON, William Barron, M.E., '01. (1) and (3) 2032 E. 115 St., Cleveland, O. (2) Sandusky Cement Co., 817 B. of L. E. Bldg., Cleveland, O. Cleveland Engineering Society, A. S. M. E.
RAY, Francis Asa, '00. Address not known.
RAYMOND, Allen Arthur, M.E., '10. Jersey Shore, Pa.
RAYMOND, Arthur Beavers, M.E., '99. 621 Colonial Bldg., Boston, Mass.
RAYMOND, Francis, M.E., '92. Sales Specialist. 12 S. Michigan Ave., Chicago, Ill. Chicago Athletic Club, Author "Raymond's Briefer Sales-Course." 1916.
RAYMOND, Miner, '11. Care Webster Mfg. Co., Tiffin, Ohio.
RAYMOND, Henry Jay, M.E., '10. 213 N. Park Ave., Warren, O.
RAYMOND, Percy Edward, A.B., '02. Museum of Comparative Zoology, Cambridge, Mass.
RAYMOND, Ralph, M.E., '00. Western Elec. Co. 463 West St., New York, N. Y.
RAYNSFORD, Robert Parker, M.E., '05. 7 Water St., Boston, Mass.
READ, Everett Charles, M.E., '17. Green Tree Rd., Milwaukee, Wis.
READ, Herbert J., M.E., '05. Carpenter. R. D. 24, Bethel, Conn.
READ, Verne Roy, M.E., '13. Superintendent-Read Benzol Co. (2) and (3) 21 N. Summit St., Akron, O. (1) 786 Chalker St., Akron, O.
READ, Walter Raymond, M.E., '15. Green Tree Road, North Milwaukee, Wis.
REBMAN, Charles Gustave, M.E., '15. 451 Canal St., New York City.
RECTOR, Mark Davis, '09. Care J. Hanbury & Co., Vancouver, B. C.
REDFIELD, George William, '02. Care General Electric Co., Phoenix Bldg., Minneapolis, Minn.
REECE, Edward Thomas, '03. Hardware Merchant, Box 107. Christchurch, New Zealand.
REECE, William Asher, M.E., '06. Care Cia General Electric Sud Americans, Inc. Railway Bldg., 158 Paseo Colon, Buenos Ayres, Argentine Rep., S. A.
REED, Chester Turner, M.E., '03. (1) and (3) 1215 Main St., Worcester, Mass. (2) Care Reed & Prince Mfg. Co., Worcester, Mass. A. S. M. E.
REED, Harrison Pierce, M.E., '09. Electrical Engineer. (3) and (1) 711 Prospect Avenue, Milwaukee, Wis. (2) Care Cutler Hammer Mfg. Co., Milwaukee, Wis. Milwaukee Sect. of A. I. E. E.
REED, Henry Joseph, '14. Little Falls, N. Y.
REED, H. C., '09. Const. Eng. N. W. Tel. Co. (2) and (3) N. W. Tel. Exchange, Minneapolis, Minn. (1) 111 Sheridan Ave., N. Minneapolis, Minn.
REED, Le Grand Bey, '95. Insurance broker, Reed, Shaw & McNaught. (2) and (3) Toronto, Ont., Can. (1) 42 Biscarth Rd., Toronto, Ont., Can.
REED, William Ebenezer, M.E., '89. (1) 175 W. 72 St., New York, N. Y. (2) and (3) 61 Broadway, Suite 3007, New York City.
REED, Joseph Carl, '92. (1) 85 Bay St., Toronto, Can. (2) and (3) Care Reed, Shaw, & McNaught, Toronto, Can.
REEDER, Nathaniel Sutherland, M.E., '96. V.-P. Pressed Steel Car Co. 24 Broad St., New York City.
REES, Arthur Frithjoff, jr., M.E., '14. 195 Western Rd., Toronto, Can.
REES, Louis du Bois, M.E., '15. 512 Kilby Ave., Wilkinsburg, Pa.
REESE, Dale F., M.E., '05. Supt. Steam Boiler & Flywheel Dept. (2) Ocean Accident and Guarantee Corp., 59 John St., New York City. (1) and (3) 311 Belleville Ave., Newark, N. J. A. S. M. E.
REESE, Jesse Lenhart, M.E., '14. (2) and (3) 511 American Bank Bldg., Seattle, Wash. (1) 1812 Harvard Ave., Seattle, Wash.
REEVES, Donald Howell, M.E., '13. Automobile Engineer. (1) and (3) 1232 John R. St., Detroit, Mich. (2) Cadillac Motor Car Co., Detroit, Mich. Society of Automobile Engineers.
REEVES, Isaac Stockton Keith, '78. New Castle, Del.
REGGIARDO, Juan, M.E., '12. Victoria, E. R., Arg. Rep., S. A.
REGISTER, Albert Layton, M.E., '89. Consulting Engineer. (1) Ardmore, Pa. (2) and (3) 410 Commercial Trust Bldg., Philadelphia, Pa.
REHR, Louis, M.E., '09. Construction Work, Maintenance of Way Dept. (1) 228 High St., Perth Amboy, N. J. (2) Public Service R. R. Co. American Electric R. R. Assoc.
REIB, Don Cleveland, M.E., '15. Care Standard Oil Co., Shanghai, China.
REIBER, Harry Paul, M.E., '08. (1) 80 Warren Ave., Crafton, Pa. (2) and (3) Care Pittsburgh Bridge & Iron Works, Pittsburgh, Pa.
REICH, Oswald David, M.E., '12. Salesman. (1) and (3) New Dorp, Staten Island, New York City. (2) Dexter Folder Co., 200 5th Ave., New York City. Tau Beta Pi.
REICH, Walter Bellinger, M.E., '15. Care Eyler & Henry, Benedum-Trees Bldg., Pittsburgh, Pa.
REID, C. R., M.M.E., '16. Ithaca, N. Y.
REID, Henry Probasco, M.E., '11. Prince Royal's College, Chiengmai, Siam.
REID, John Simpson, jr., '09. 43 E. 33d St., Chicago, Ill.
REID, Walter Lincoln, '09. 44 Vernon Ave., Mt. Vernon, N. Y.
REID, William Hammond, M.E., '11. Care American Locomotive Co., Le Havre, France.
REIGHARDT, Horace Robert, M.E., '08. 1038 Euclid Ave., Cleveland, Ohio.
REILEY, Frederick Asbury, M.E., '10. Engrg Asst. to Mgr. (2) and (3) Waterbury Gas Light Co., Waterbury, Conn. (1) 44 Willow St., Waterbury, Conn. Am. Gas Inst.
REINHARDT, Fred, M.E., '12. Engrg. Dept. N. Y. Tel. Co. (2) 25 Dey St., New York City. (1) and (3) 2 Summit Ave., Yonkers, N. Y. Telephone Society of New York.
REINHARDT, Julius Emil, M.E., '99. 517 Oakdale Ave., Chicago, Ill.
REINICKER, Norman G., M.E., '11. Asst. to Chief Engr., N. Y. Edison Co. (1) 15th and Irving Place, New York City. (2) and (3) 130 E. 15th St., New York City. A. S. M. E., New York Elec. Soc.
REINKE, Arthur Eduard, M.E., '96. Western Elec. Co., Ltd., North Woolwich, London, Eng. A. I. E. E. Sec.
REMICK, Frederick Ninian, '05. 590 Ellicott Sq., Buffalo, N. Y
REMSEN, Charles C., M.E., '01. Dept. Mgr., Diehl Mfg. Co. (1) 1153 Broad St., Newark, N. J. (2) and (3) 90 Prince St., New York City.
REMSEN, Theo. G., M.E., '08. Asst. Sales Mgr. (2) and (3) Care Hill Clarke & Co., 125 N. Canal St., Chicago, Ill. (1) 320 S. Ridgeland Ave., Oak Park, Ill.
RENNER, Roland Borman, M.E., '04. (2) Jeffrey Mfg. Co., 50 Dey St., New York City. (1) and (3) 3810 Broadway, New York City. A. S. M. E.
RENO, John Linford, '09. 7464 McClure Ave., Swissvale, Pa.
RENOLD, Charles Garonno, M.E., '06. Priestnoll Hey, Heaton Mersey, Manchester, Eng.
RENTON, James Lewis, M.E., '12. Ewa, Oaku, Hawaii.
REPLOGLE, Harry Leroy, '07. 131 Greene St., Johnstown, Pa.
de RETANA, Anselmo Ochoa, M.E., '14. Buenos Aires, Arg. Rep., S. A.
RETICK, Joseph George, B.S.A., '11. 337 W. Center St., Shenandoah, Pa.
REUMAN, Christian Herman, M.E., '14. New Bedford, Mass.
REWALT, John Kendig, M.E., '11. Gear Designer. (1) 393 Court St., Rochester, N. Y. (3) and (2) 1000 University Ave., Rochester, N. Y.
REYMOND, P. L., M.E., '17. Fitter in Ship Yards. (1) and (3) 33 Edison St., Quincey, Mass. (2) Fore River Shipbuilding Corporation.
Reymond, Paul LeGrand, M.E., '17. Fitter in Ship Yards. (1) and (3) 33 Edison St., Quincy, Mass. (2) Fore River Shipbuilding Corporation.
REYNA, Juan Estevan, '98. Instructor. Cornell Univ., Ithaca, N. Y.
REYNA, Ysidro, M.E., '97. 120 Broadway, New York City.
REYNEAU, Paul Ortmans, M.E., '13. Edison Illuminating Co. (2) and (3) 18 Washington Ave., Detroit, Mich. (1) 20 Kirby Ave. West, Detroit, Mich.
REYNOLDS, Grey James, '02. Address not known.
REYNOLDS, Herbert Byron, M.M.E., '15. Asst. Engr., M. P. Dept., Interborough Rapid Transit Co. (1) 149 N. Broadway, Yonkers, N. Y. (2) and (3) 621 Broadway, Room 823, New York City. Jun. A. S. M. E., A. I. E. E., Sigma Xi.
REYNOLDS, Ralph Keeler, M.E., '17. 37 Pleasant St., Danbury, Conn.
REYNOLDS, Robert L., M.E., '97. Farmer. (1) La Habra Cal., P. O. Box 419. (2) Care Graham Reynolds Elec. Co., 300 E. Third St., Los Angeles, Cal.
REYNOLDS, Joseph Fleming, M.E., '02. Address not known.
REYNOLDS, William Grant, '94. Amboy, Ill.

RHAME, FRANK PHIPPS, M.E., '09. (2) Engr. Exam. N. Y. Municipal C. S. Comm., Municipal Bldg., New York City. (1) and (3) Wantagh, L. I., N. Y.
RHODES, CHARLES FOSTER, M.E., '03. Supt. Bureau of Tests. (1) 26 Fulton St., Glens Falls, N. Y. (2) International Paper Co., Glen Falls, N. Y. Tech. Assoc. of the Pulp and Paper Industry, A. S. T. M.
RICE, ARTHUR LEWIS, M.M.E., '96. Editor, "The Engineer." 537 Dearborn St., Chicago, Ill.
RICE, FREDERICK CLINTON, M.E., '08. 491 Hancock St., Brooklyn, N. Y.
RICE, GEORGE W., M.E., '03, M.M.E., '06. Works Mgr., Aultman Taylor Mach. Co., Mansfield, Ohio. (1) and (3) 188 W. First St., Mansfield, O. A. S. M. E., A. S. A. E.
RICE, HAROLD KINNEY, '92. 1516 Clarence Ave., Cleveland, O.
RICE, HOWARD C., M.E., '05. Asst. Gen. Mgr., C. Kurtzmann Co. (2) 526 Niagara St., Buffalo, N. Y. (1) and (3) 670 Auburn Ave., Buffalo, N. Y.
RICE, LOUIS ALBERT, M.E., '01. Farmer and poultry. Randolph, N. Y.
RICE, ORMAN RENNINGTON, '97. 23 Thames St., Newport, R. I.
RICE, SAMUEL FROST, '07. 312 Shillito St., Cincinnati, O.
RICE, THOMAS ALEXANDER, M.E., '16. 81 Charles St., Hamilton, Ont. A. S. M. E.
RICE, WALDO HUNTLING, M.E., '16. Lee, Mass. A. S. M. E., A. I. E. E.
RICE, WILLIS BALLANCE, '07. (1) 1913 Park Rd., N. W., Washington, D. C. (2) and (3) Asst. Examiner, Patent Off., Washington, D. C.
RICH, CHAS. A., M.E., '94. Brown Sharpe Mfg. Co., 208 Indiana Ave., Providence, R. I. Prov. Soc. Mech. Eng.
RICH, SIDNEY LEONARD, M.E., '02. 330 S. Pryor St., Atlanta, Ga.
RICHARDS, CHARLES RUSS, M.M.E., '95. Prof. University of Ill. 807 W. Oregon St., Urbana, Ill.
RICHARDS, FRED THOMAS, M.E., '97. 1540 E. 36 St., Los Angeles, Cal.
RICHARDS, WALTER BARNES, '83. Hardware Merchant, 4553 Walnut St., Kansas City, Mo.
RICHARDSON, ALTON A., M.E., '98. Engr., Castner Electrolytic Alkali Co., 526 11th St., Niagara Falls, N. Y. A. S. M. E., Eng. Soc. of Buffalo, N. Y.
RICHARDSON, EDWARD MANSFIELD, '97. Maywood, Ill.
RICHARDSON, EDWARD RILEY, '04. Woodstown, N. J.
RICHARDSON, EDWARD THOMAS, '13. (1) 94 Park Ave., Portland, Me. (2) and (3) Cor. Commonwealth Ave. and Beacon Sts., Boston, Mass.
RICHARDSON, LAWRENCE, M.E., '10. M. P. Inspector—Penn. R. R. (2) and (3) 203 Penna. Station, Pittsburgh, Pa. (1) 1232 South 6th St., Louisville, Ky.
RICHARDSON, LUTHER L., '17. 689 Greene Ave., Brooklyn, N. Y.
RICHARDSON, THOS. S., '02. Treas. Kilmer Richardson Co., Inc. (2) 60-62 Genesee St., Auburn, N. Y. (1) and (3) 73 South St., Auburn, N. Y. A. I. E. E.
RICHEY, ARCHIE LAWSON, M.E., '11. Telephone Engineer. (1) 120 Montague St., Brooklyn, N. Y. (2) New York Telephone Co., 15 Day St., New York. A. I. E. E.
RICHIE, DAVID ROBERTS, M.E., '97. Chief Draftsman, S. L. Allen & Co. (3) and (2) 5th and Glenwood Ave., Philadelphia, Pa. (1) 18 Violet Lane, Lansdowne, Pa. Cornell Club of Phila., Franklin Institute.
RICHMOND, JAMES, M.E., '02. Pres. Richmond Mfg. Co., Lockport, N. Y.
RICHMOND, PHILIP ALFRED, '13. 282 High St., Lockport, N. Y.
RICHTER, ARTHUR WILLIAM, M.M.E., '99. Dean, School of Eng'g, Univ. of Montana. (2) Missoula, Mont. (1) and (3) 1414 Maurice Ave., Missoula, Mont.
RICK, CHARLES MADEIRA, M.E., '06. Chemist. 431 Windsor St., Reading, Pa.
RICKER, CHESTER S., M.E., '11. Consulting Eng. and Pres. Ricker Oil Co. (1) 208 E. 32d St., Indianapolis, Ind. (2) and (3) 1201 State Life Bldg., Indianapolis, Ind. Soc. of Automobile Engineers.
RICKER, WILLIAM TODD, M.E., '96. Sec. Treas., Guarantee Construction Co., 90 West St., New York City.
RICKETSON, WILLIAM ELBRIDGE, M.E., '07. 3428 Broadway, Indianapolis, Ind.
RIDGWAY, A. S., M.E., '16. (1) 72 Adams St., Akron, O. (2) Goodyear Tire and Rubber Co. (3) Planning Dept., Akron, O.
RIGBY, GEORGE NORTON, '95. Laywer, 45 Washburton Ave., Yonkers, N. Y. 63 Sunnyside Drive, Yonkers, N. Y.
RIGDON, H., '16. Sharon, Md.
RIGGS, LELAND WRIGHT, M.E., '10. (1) 27 Grove Pl., Schenectady, N. Y. (2) and (3) Care American Mfg. Co., Brooklyn, N. Y.
RIKER, CHAS. MELVILLE, M.E., '96. 577 52d St., Brooklyn, N. Y.
RILEY, CHAMPLAIN LORD, M.E., '99. 7 Myrtle Ave., Plainfield, N. J.
RILEY, HOWARD WAIT, M.E., '01. Professor Cornell University. R. F. D. 7, Ithaca, N. Y.
RILEY, WILLIAM HERMON, M.E., '86. 1029 Adams St., Wilmington, Del.
RINKE, GEORGE RAYMOND, M.E., '13. Power Engineer. (2) United Electric Light & Water Co., Waterbury, Conn. (1) and (3) 601 West 160 St., New York City.
RIPLEY, JOSEPH PIERCE, M.E., '12. (2) and (3) Care J. G. White & Co., Exchange Place, New York City. (1) West Side Y. M. C. A., 318 W. 57th St., New York City.
RIPLEY, WILLIAM HENRY, M.E., '12. (1) 173 Hicks St., Brooklyn, N. Y. (2) and (3) Griscom-Russell Co., New York City.
RISING, JUSTUS, M.E., '13. 123 Griffith St., Corning, N. Y.
RISSINGER, R. H., M.E., '14. 708 Monroe Ave., Scranton, Pa.
RISTINE, GEORGE W., JR., M.E., '01. 1470 Old Colony Bldg., Chicago, Ill.
RISTINE, JOHN DIXON, '04. R. R. Repr., 470 The Rookery, Chicago, Ill.
RITER, LEVI JENNINGS, M.E., '08. 349 E. South St., Salt Lake City, Utah.
RITER, SAMUEL NEELY, '97. 55 Water St., Pittsburgh, Pa.
RITSCHARD, VICTOR, M.E., '11. Asst. Master Mechanic. (1) Riverside, N. J. (2) Keystone Watch Case Co., Riverside, N. J. Tau Beta Pi.
RITTENHOUSE, CHAS. E., M.E., '08. 226 5th Ave., New York City.
RITTENHOUSE, GEORGE MANNING, JR., M.E., '10. 44 Sanford Ave., Plainfield, N. J.
RITTENHOUSE, JOHN VINCENT, '04. Mining Engr., 44 Sanford Ave., Plainfield, N. J.
RITTER, HENRY HANSELL, M.E., '96. Care Automatic Sprinkler Co. (1) 123 William St., New York, N. Y.
RITTER, HORACE SHELDON, M.E., '11. (1) 41 Grove St., Oneonta, N. Y. (2) and (3) 211 W. 4th St., Olean, N. Y.
RITTER, ROLLIN VON, M.E., '03. Engr., U. S. Reclamation Service. Durango, Col.
RITZWOLLER, EUGENE MAX, M.E., '05. (1) 2119 W. 48 St., Chicago, Ill. (2) and (3) Care H. M. Ritzwoller Co.
ROAT, GROVER CLEVELAND, M.E., '06. Canandaigua, N. Y.
ROBBINS, CHARLES COOK, '93. Address not known.
ROBBINS, FRANCIS JOHN, M.E., '15. In Power Dept. (1) and (3) 422 N. 7th St., Hannibal, Mo. (2) Atlas Portland Cement Co., Hannibal, Mo. A. I. E. E.
ROBBINS, HAROLD WALBRIDGE, M.E., '08. Care The Arnold Co., Barland Bldg., Chicago, Ill.
ROBBINS, HARRY EUGENE, '89. Pittsfield, Mass.
ROBBINS, JOHN LORING, M.E., '07. Mech. Engr. (2) and (3) Robbins Granwell & Co., Pittsfield, Mass. (1) 248 South Appleton Ave., Pittsfield, Mass. A. S. M. E.
ROBBINS, NATHANIEL C., '94. 226 Elderwood Ave., Pelham, N. Y.
ROBBINS, PERCY ARTHUR, M.E., '94. Can. Min. & Finance Co., Pemmins, Ont., Can.
ROBBINS, RALPH WELLINGTON, M.E., '01. 497 S. Goodman St., Rochester, N. Y.
ROBBINS, WILLIAM MARION, M.E., '09. Clover Club, Edgewood Park, Pittsburg, Pa.
ROBERT, LEROY CLINTON, M.E., '07. Address not known.
ROBERTS, ARCHIBALD BRADSHAW, M.E., '14. Banker. Enfanla, Ala.
ROBERTS, ARTHUR MEREDYTH, M.E., '11. 2030 Quinlan Ave., Birmingham, Ala.
ROBERTS, ALFRED MOSS, M.E., '09. Wanakah Mining Co., Ouray, Colo.
ROBERTS, CHARLES ALFONSO, M.E., '04. Conn. River Transmission Co. 801 Osgood Bradley Bldg., Worcester, Mass.
ROBERTS, EDMUND WILLSON, M.E., '95. Consulting Engineer, Editor "The Gas Engine." (1) 409 McAlpin Ave., Clifton, Cincinnati, O. (2) and (3) 580 Cincinnati, O. National Gas Engine Association.
ROBERTS, ELLWOOD WALTER, '74. 281 4th Ave., New York City.
ROBERTS, OWEN WILBUR, M.E., '01. 231 W. Grand Ave., Chicago, Ill.
ROBERTSON, LEWIS ARCHER, '04. Address not known.
ROBERTSON, LESLIE COLVILLE, Sp. M.E., '15. Adelaide St., Brisbane, Australia.
ROBERTSON, RALPH NOYES, M.E., '05. 2931 Perry St., Denver, Col.
ROBERTSON, WILLIAM EWART, '95. 199 Anderson Pl., Buffalo, N. Y.
ROBERTSON, WILLIAM LOURO, '95. Address not known.
ROBERTSON, WILLIAM WALLACE, JR., M.E., '17. 394 Goundry St., N. Tonawanda, N. Y.
ROBINSON, CHAS. ALBERT, JR., M.E., '06. Address not known.
ROBINSON, CHAS. WALRATH, M.E., '94. (1) 4 Cottage Ave., Hamilton, Ont., Can. (2) and (3) Supt., Experiments, I. H. Co., Hamilton, Ont.
ROBINSON, GEORGE EDMUND, M.E., '10. Sales Engr., Mead Morrison Mfg. Co. (1) and (3) 102 Highland Rd., Somerville, Mass. (2) 25 Prescott St., East Boston, Mass.
ROBINSON, GORDON DUDLEY, M.E., '14. Instructor Electrical Engineering. (1) (2) and (3) 223 E. Nittany Ave., State College, Pa. A. I. E. E., Univ. Club, State College.
ROBINSON, JAMES REED, '91. 1007 Diamond Bank Bldg., Pittsburgh, Pa.
ROBINSON, KINSEY, M.E., '14. (1) 400 Union St., Joliet, Ill. (2) Care Am. Can Co., Hamilton, O.
ROBINSON, LESTER LUDYAH, '94. Address not known.
ROBINSON, ORIN POMEROY, JR., '15. 60 E. Third St., Corning, N. Y.
ROBINSON, RAY MCLEOD, M.E., '12. 202 Kenwood Ave., Rochester, N. Y.
ROBINSON, WILLIAM ALEXANDER, M.E., '06. (1) 807 W. 5th St., Sterling, Ill. (2) and (3) Sec. and Supt. Charter Gas Engine Co., Sterling, Ill.
ROBINSON, WILLIAM CHRISTOPHER, M.E., '05. Holland Patent, N. Y.
ROBINSON, WILLIAM COLIN, '91. 207 E. Ohio St., Chicago, Ill.
ROCAP, CHARLES CLARENCE, M.E., '08. 1045 Myrtle Ave., Plainfield, N. J.
ROCKHILL, CLAYTON ROBESON, M.E., '13. 114 John St., New York City.
ROCKWELL, ARCHIE GORDON, M.E., '08. 3901 Wabash Ave., Chicago, Ill.
ROCKWELL, GEO. H., '13. (1) and (3) 183 Babcock St., Brookline, Mass. (2) Supt. The Cambridge Rubber Co., 748 Main St., Cambridge, Mass.
ROCKWELL, JAMES CHAPMAN, M.E., '07. Manila Elec. R. R. & Lt. Co., Manila, P. I.
ROCKWOOD, DWIGHT CARRINGTON, M.E., '99. 57 Rutgers St., Rochester, N. Y.
ROCKWOOD, HAROLD ARTHUR, '09. Boys' Work, Sec. Y. M. C. A. 156 James Place, Buffalo, N. Y.
RODDEWIG, GEORGE WASHINGTON, M.E., '06. Federal Lead Co., Flat River, Mo.
ROESE, C. J., M.E., '16. 3223 Main St., Buffalo, N. Y.
RODGERS, RALPH CHAPMAN, M.E., '05, A.M., '08. Instructor, Cornell Univ. 406 N Cayuga St., Ithaca, N. Y.
RODRIGUEZ, JOSÉ GEGUNDO, '11. Address not known.
RODRIGUEZ, RODRIGO BENNETT, M.E., '15. 349 Rugby Ave., Brooklyn, N. Y.
ROE, MARK WOODHULL, M.E., '96. 376 N. Market St., E. Palestine, O.
ROE, MAYO EUGENE, M.E., '04. 312 6 St., Elyria, O.
ROEDELHEIM, ALFRED MAX, M.E., '96. 527 S. 5 Ave., Chicago, Ill.
ROEHRIG, HAROLD LIVERMORE, M.E., '14. 501 Oakland Ave., Pasadena, Cal.
ROEHL, FRED AUGUST, '95.
ROESE, CHARLES J., '16. Goodyear Tire & Rubber Co. (1) R. F. D. 4, Ravenna, O. (2) and (3) Akron, O.
ROESS, CHARLES WILLIAM, M.E., '93. 204 Reed St., Oil City, Pa.
ROESSEL, LOUIS CARL HERMANN, '08. 319 Lafayette Ave., Brooklyn, N. Y.
ROGAN, RALPH FREDERIC, M.E., '97. Engineer. Glendale, O.
ROGERS, ALLAN BALDWIN, M.E., '10. Care Holly Sugar Co., Huntington Beach, Cal.
ROGERS, ASA LEROY, M.E., '12. Junior Eng. (2) and (3) 309 Broadway, New York City. (1) Demarest, N. J.
ROGERS, CHARLES EDWARD, M.E., '96. Care Frazey & Chalmers, Ltd., Erith, England.
ROGERS, CLARENCE RAMSEY, M.E., '07. Corry, Pa.
ROGERS, FRED STILLMAN, M.E., '13. 121 College Ave., Ithaca, N. Y.
ROGERS, FRED NEWTON, '90. Black Hawk, Colo.
ROGERS, GARDINER MERRIMAN, M.E., '11, A.B., '13. Care D. B. Stewart & Co., Ithaca, N. Y.
ROGERS, HENRY ALBERT, M.E., '03. 127 Mt. Airy Ave., Mt. Airy, Pa.
ROGERS, HERMAN LEON, M.E., '08. Steamfitter. Stony Brook, L. I., N. Y.
ROGERS, HOWARD MAXWELL, M.E., '07. Dealer and Mfgr., Oils and Greases (2) Proprietor of W. T. Benson & Co., Riverton, N. J. (1) and (3) 232 N. Front St., Philadelphia, Pa.
ROGERS, HENRY GEER, '01. Sable Forks, N. Y.
ROGERS, JOHN DALRYMPLE, M.E., '09. 225 4th Ave., South, Pocatello, Idaho.
ROGERS, JOHN MULHALL, M.E., '15. (2) and (3) Care Curtiss Aeroplane Co., Buffalo, N. Y. (1) 160 Adam St., Tonawanda, N. Y.
ROGERS, ROBERT WILSON, M.E., '04. 25 Ferguson Ave., Port Jervis, N. Y.
ROGERS, WILLIAM HAYWOOD, '09. 229 Mt. Vernon St., Camden, N. J.
ROGERS, ZEBBIE GEORGE, '98. Address not known.
ROHR, CHARLES ARNOLD, M.E., '11. Care General Elec. Co. (2) and (3) 30 Church St., New York City. (1) 65 W. 71 St., New York, N. Y.
ROLPH, THOMAS WILLETT, M.E., '07. Illuminating Engr., Ivanhoe Metal Works of G. E. Co. (2) and (3) Care Ivanhoe Metal Works, Cleveland, Ohio. (1) 30 Hastings Ave., E. Cleveland, O. I. E. S., A. I. E. E.
ROMM, NEHEMIAH, M.E., '13. 805 St. Nicholas Ave., New York, N. Y.
RONEY, WILLIAM WHEELER, M.E., '05. 161 Summer St., Boston, Mass.
ROOF, JAMES RUSSELL, M.E., '14. Newton, N. J.
ROOS, DELMAR GERLE, M.E., '11. Staff Engr. Locomobile Co. of Am., Bridgeport, Conn.
ROOS, OSCAR CHRISTIAN, '03. 9 Pleasant St., Cambridge, Mass.
ROOT, EDWARD, '89. Care Lyon & Healy, 200 S. Wabash Ave., Chicago, Ill.
ROOT, LOUIS DENMAN, '08. 233 Broadway, New York City.
ROOT, SAMUEL CHARLES, M.E., '01. Engr. of Maintenance and Repairs. (2) and (3) Care Solvay Process Co., Detroit, Mich. (1) 96 East Euclid Ave. Detroit Engineering Soc.

ROPER, Denney W., M.E., '93. Supt. Street Dept., Commonwealth Edison Co. Room 500, 72 W. Adams St., Chicago, Ill.
ROPER, Mabon Powell, M.E., '14. Treas. Elipse Gas Stove Co. (1) and (3) 1031 Franklin Place, Rockford, Ill. (2) 707 S. Main St., Rockford, Ill.
ROPES, John Marling, M.E., '17. Englewood Cliffs, N. J.
RORTY, Malcom Churchill, '96. American Tel. & Tel. Co. (1) and (3) Great Neck Station, Long Island. (2) 195 Broadway, New York. Sigma Xi, A. I. E. E.
ROS, Antonio Maximo, '94.
ROSE, Alexander, Spec., '92. Box 581, Greenville, S. C.
ROSE, Arthur Lawson, M.E., '10. 527 Franklin St., Detroit, Mich.
ROSE, Clarence Edward, ME., '05. 516 W. 16 St., Little Rock, Ark.
ROSE, Geo. Stanton, M.E., '04. Sales Engr. (2) and (3) Room 1701, 30 Church St., New York City. (1) 643 Palisade Ave., Yonkers, N. Y. A. I. E. E., Machy. Club of N. Y.
ROSE, Harry, '01. 112 Bennett St., Three Rivers, Mich.
ROSE, James Vincent, jr., '13. 32 W. State St., Sharon, Pa.
ROSE, Wm. H., M.E., '97. Pres. Interstate Chem. Co., (3) and (2) Bay View Ave., Jersey City, N. J. (1) 109 Fairview Ave.
ROSEBRO, Henry Rutherford, M.E., '12. Asst. to Gen. Mgr., Southern Utilities Co. (1) and (2) Jacksonville, Fla. (3) P. O. Box 1573. A. S. R. E.
ROSENBLATT, Maurice Cohn, M.E., '11. Mechanical Engineer. (1) and (3) 3 N. Brighton Ave., Atlantic City, N. J. (2) Atlantic City, N. J.
ROSENCRANZ, Richard, '05. Vulcan Plow Co., Evansville, Ind.
ROSENTENGEL, Rudolph, M.M.E., '12. 317 S. 25th St., Paris, Tex.
ROSENSTEIN, Leo, M.E., '09. 815 Belmont St., Portland, Ore.
Rosenthal, George Washington, M.E., '13. 991 Marion Ave., Cincinnati, O.
ROSENTHAL, William Charles, M.E., '11. Chief Engineer. (1) and (3) 840 Lexington Ave., Avondale, Cincinnati, O. (2) The Enger Motor Car Co., Cincinnati, O.
ROSEVEAR, Morris Burt, M.E., '08. Supt. of Distribution. (1) 27 Edgar St., East Orange, N. J. (2) Public Service Terminal, Newark, N. J. A. E. R. A., A. I. E. E.
ROSS, James Dunbar, M.E., '12. 555 Nostrand Ave., Brooklyn, N. Y.
ROSS, Taylor William, M.E., '95. Supt. Repairs and Docks. (2) and (3) Newport News, Va. (1) 3114 West Ave., Newport News, Va.
ROSSIRE, Henry Lansing, M.E., '08. Lowerre Summit Park, Yonkers, N.Y.
ROSSITER, Winton G., M.E., '11. (2) Nichols Copper Co., Laurel Hill, L. I. (1) and (3) 342 Willow St., Richmond Hill, N. Y.
ROSSMAN, Allen M., M.E., '06. 1235 Elmwood Ave., Wilmette, Ill.
ROTH, Rodolfo, M.E., '09. Florida 440, Buenos Aires, Arg. Rep., S. A.
ROTH, Walter Earl, M.E., '17. 149 Parkview Ave., Buffalo, N. Y.
ROTHMALER, Oswald, M.E., '13. Elec. Engr., Transit Development Co. (2) and (3) Kent & Division Ave., Brooklyn, N. Y. (1) 1239 Bergen St., Brooklyn, N. Y.
ROUDEBUSH, Roy Everett, M.E., '07. 306 Argyle St., Waterloo, Ia.
ROUSE, Warren Eggleston, M.E., '13. Draftsman, Waterbury Tool Co., Waterbury, Conn.
ROWE, Bertrand Perry, M.E., '92. 911 Ramsey Ave., Wilkinsburg Sta., Pittsburg, Pa.
ROWE, James Gordon, jr., M.E., '14. Box 577, Butler, Pa.
ROWE, Norman, M.E., '93. Chile Exploration Co., Tocapilla, Chile.
ROWE, Oruis Fletcher, '10. Elec. Eng., Westinghouse Electric Mfg. Co. East Pittsburg, Pa. 1311 Center St., Wilkinsburg, Pa.
ROWE, William Alphonso, M.E., '03. Marlborough Apts., Darragh & Victoria Sts., Pittsburg, Pa.
ROWLAND, Arthur Eugene, '13. Lieut., Fort Andrews, Mass.
ROWLAND, Harry Shepard, M.E., '06. 77 Park St., Montclair, N. J.
ROYCE, Knibloc Perry, M.E., '16. Sales Engr., Burk Elec. Co., Erie, Pa. 226 Oneida St., Fulton, N. Y. A. I. E. E.
ROYSE, Daniel, M.M.E., '91. 120 Broadway, New York, N. Y.
ROYSTON, Fletcher Eugene, '14. Asst. Buyer Wholesale Groceries. (1) 472 Downer Place, Aurora, Ill. (2) and (3) F. E. Royston & Co., Aurora, Ill. Masonic Order Blue Lodge.
ROZIER, Julius Brady, jr., '09. 86 N. 2 St., Memphis, Tenn.
RUBIRA, Adriano Woodruff, '05. 156 St. Anthony St., Mobile, Ala.
RUBY, George Casper, M.E., '15. 759 W. Locust St., York, Pa.
RUDIGER, John Max, jr., '82. Floral Park, L. I., N. J.
RUDOLF, Walter Edward, '11. (1) 1527 Kenilworth Ave., Rodgers Pk., Chicago, Ill. (2) and (3) Chicago White Lead & Oil Co.
RUDOLPH, Walter Henry, M.E., '12. 363 W. 119 St., New York, N. Y.
RUFO, Henry Nimes, M.E., '02. Address not known.
RUHLEN, George, jr., M.E., '07. Care Adjutant General U. S. Army, Washington, D. C. Lieut. Coast Artillery Corps.
RUIZ, Juan José, M.E., '17, A.B. Banes, Ote, Cuba. Eta Kappa Nu, A. I. E. E.
RUMF, William August, '79. 27 Bolskos Prospect W. O., Petrograd, Russia.
RUMSEY, Eugene Aerstin, M.E., '90. 1211 Filbert St., Philadelphia, Pa.
RUMSEY, George Augustin, jr., '93. 1211 Filbert St., Philadelphia, Pa.
RUMSEY, Lawrence Cooper, M.E., '12. 310 W. State St., Ithaca, N. Y.
RUNDLE, H. E., M.E., '13. 611 Iron Mt. St., Iron Mountain, Mich.
RUNGE, Henry Julius, '10. Sale and Installation of Machinery. (1) 2809 Ave. J., Galveston, Texas. (2) and (3) 213 22d St., Galveston, Texas. A. I. E. E.
RUNYON, C. R., M.E., '14. 81 Locust Hill Ave., Yonkers, N. Y.
RUNYON, Walter Clark, jr., '08. 1316 Citizens Bldg., Cleveland, O.
RUSHER, Merlin A., M.E., '10. 170 Nott Terrace, Schenectady, N. Y.
RUSHMORE, Clare, '00. Address not known.
RUSHMORE, David Barker, M.E., '95. (1) 234 Union St., Schenectady, N. Y. (2) and (3) Care General Electric Co.
RUSSELL, Claude Hartwell, '04. Broadway, Geneva, Ohio.
RUSSELL, Floyd Lester, M.E., '12. 44 Bleeker St., Newark, N. J.
RUSSELL, Howard C., M.E., '16. Supt. Distribution Dept. (1) and (3) 11 S. Oxford St., Brooklyn, N. Y. (2) Brooklyn Universal Gas Co., 176 Remsen St., Brooklyn, N. Y.
RUSSELL, Joseph Grandin, '79. 642 8th Ave., San Francisco, Cal.
RUSSELL, Parvin Masters, M.E., '15. Lansdowne, Pa., The Knoll.
RUSSELL, Reginald Henry, M.E., '13. 24 Glenwood Blvd., Schenectady, N. Y.
RUSSELL, Stanley Addison, M.E., '12. (1) 6814 Greenview Ave., Chicago, Ill. (2) and (3) Harris Trust & Sav. Bank, Chicago, Ill.
RUSSELL, William James, M.E., '13. (1) 22 Orpheum Block, Niagara Falls, N. Y. (2) and (3) American Cyanamid Co., Niagara Falls, Ont., Can.
RUSSELL, Witmer, M.E., '11. Address not known.
RUST, Fleet Singleton, M.E., '11. Harden, Mo.
RUTLAND, Carl James, '15. 237 Coddo St., Commerce, Texas.
RUTLEDGE, Joseph Ervin, M.E., '11. Y. M. C. A., Newark, N. J.
RUTZLER, Joseph Enoch, M.E., '99. (1) 404 E. 49 St., New York, N. Y. (2) and (3) E. Rutzler & Co., Mfg. of Steam and Hot Water Apparatus.
RYAN, Claude Gilbert, '14. Box 218, Halifax, Pa.
RYAN, Harris Joseph, M.E., '87. Professor, Stanford Univ., Palo Alto, Cal.
RYAN, Lawrence Marvin, M.E., '08. Sec. and Treas. (2) and (3) Cambria & Moshannon Coal Co., Altoona, Pa. (1) 312 Waverly Ave., Syracuse, N. Y.
RYAN, William John, M.E., '11. 202 Riverside Dr., New York, N. Y.
RYDER, Ambrose, M.E., '13. Mgr. Universal Inspection Co. (2) 612 Canal Bk. Bldg., New Orleans, La. (1) and (3) Carmel, N. J.
RYDER, Earle Ambrose, M.E., '11. Motor Car Designer. (1) and (3) Nutley, N. J. 1790 Broadway, New York City. Soc. of Auto Engineers.
RYDER, Earl Raymond, M.E., '15. 142 Dorchester Rd., Buffalo, N. Y.
RYDER, L. C., M.E., '14. Carmel, N. Y.
RYTHER, George DeGroot, '89. Carthage, N. Y.
SAALFIELD, Robert Sutton, M.E., '15. 24 N. Prospect St., Akron, O.
SACKMAN, Gilbert Roy, M.E., '07. 345 E. 15 St., New York, N. Y.
SAILOR, George Raymond, M.E., '07. Sec. Buchner Lumber Co. (1) and (2) North Bend, Coos Bay, Oregon.
SAILOR, Horace Price, M.E., '06. St. Johns Univ., Shanghai, China.
SALAS Y RODRIGUEZ, Mariano Julio, M.E., '12. 71 Alejandro VI, Manila, P. I.
SALINGER, Arthur, jr., M.E., '17. 235 W. 103d St., New York City.
SALISBURY, Earle Edwin, '15. 5142 Cabanne Ave., St. Louis, Mo.
SALISBURY, George Champlin, '12. Route 1, Randolph, N. Y.
SALISBURY, Myron Davis, M.E., '07. 151 Kensington Ave., Buffalo, N.Y.
SALISBURY, Orange James, jr., M.E., '05. 207 Felt Bldg., Salt Lake City, Utah.
SALISBURY, Robert Walker, M.E., '06. 574 E. 1 St., Salt Lake City, U.
SALLADA, Charles Wilbur, '96. 253 Pine St., Williamsport, Pa.
SALMOW, Louis, '14. (Salmowitz, Louis), M.E., '14. Nat. Ever Ready Works, Long Island City, N. Y.
SALTZMAN, Auguste Leopold, '97. Address not known.
SAMKOFF, Julius, '14. 1534 Webster Ave., New York City.
SAMISH, Elmer Gabriel, '06. 4242 Lindell Blvd., St. Louis, Mo.
SAMPAIO, Roberto de Mesquito, M.E., '08. Rua Viscon de Rio Branco 39, Sao Paulo, Brazil.
SAMPAIO, Vicente de Almeida, M.E., '07. Ruo Visconde, Rio Branco, 39, San Paulo, Brazil, S. A.
SAMPLE, Morris de Frees, M.E., '94. (1) 2264 W. Grand Blvd., Detroit, Mich. (2) and (3) Sec. and Treas., Fire Protection Co., 472 E. Woodbridge St., Detroit, Mich.
SANDERS, Francis Nicoll, '92. 235 State St., Albany, N. Y.
SANDERS, Thomas Richard, '02. (1) 165 Bellingham Ave., Beachmont, Mass. (2) and (3) 97 Heaverhill St., Boston, Mass.
SANDERS, Walter Edward, M.E., '03. 903 Central Ave., Trenton, N. J.
SANDERSON, Charles Reed, M.E., '95. Tenafly, N. J.
SANDERSON, Edward Nash, M.E., '87. 60 Broadway, New York, N. Y.
SANDERSON, Edward Spalding, M.E., '94. Mfr. and sales mgr. (2) Scoville Mfg. Co., Waterbury, Conn. (1) and (3) 155 Buckingham St., Waterbury, Conn. A. S. M. E., S. A. E.
SANDS, Ord Leydard, '95. 173 E. 38th St., New York City.
SANER, E. W., '14. 114 Durango St., El Paso, Texas.
SANFORD, John Alden, '15. (2) and (3) Ingersoll-Rand Co., Painted Post N. Y. (1) Warwick, N. Y. A. S. M. E.
SANFORD, John Alexander, '16. Changed name, formerly was John Alexander. Turbine Dept., G. E. Co., Schenectady, N. Y.
SANFORD, Linus, jr., '95. Jackson, Mo.
SANFORD, Warren B., M.E., '01. Purchasing Engr. (2) Room 1306, 195 Broadway, New York City. (1) and (3) 139 W. 11th St., New York City. A. I. E. E., A. S. M. E., I. E. S., Sigma Xi.
SANGER, George Hutchins, '04. Address unknown.
SANO, Shiro, M.M.E., '09. 26 Shitaga, Tokio, Japan.
SANTOLALLA, Eloy Uldarico, II, Address unknown.
SAQUI, Frederick Manuel, '10. Papantla, Vera Cruz, Mexico.
SARDINA, Septimio Cesareo, M.E., '14, (Sardinay, Segrera, S. C.), P. O. Box 12, Cardenas, Cuba.
SARMIENTO, Arturo, M.E., '08. Rivadavia 575 San Juan, Argentine Rep., S. A.
SATTERLEE, John Paul, M.E., '00. Gales Ferry, Conn.
SAUERHERING, Richard Paul, M.E., '00. Mayville, Wis.
SAULINER, T., M.E., '16. 438 S. Ave., Media, Pa.
SAULSBURY, Henry Wilson, M.E., '06. 64 Fulton St., New York, N. Y.
SAUNDERS, Fleming, M.E., '99. Evington, Va.
SAUNDERS, William Laphant, '99. 364 Palisade Ave., Yonkers, N. Y.
SAUTER, William Vitus, '10. American Engrg. Co. (1) 3108 N. Broad St., Philadelphia, Pa. (2) and (3) Aramingo Ave. and Cumberland St., Philadelphia, Pa.
SAVERY, Thomas H., jr., M.E., '96. Mech & Consulting Engr. 807 West Adams St., Sandusky, O.
SAVORY, Gerald, M.E., '04. Motor Works. 5 Montpelier Terrace, Teddington, S. W., England.
SAWDON, Will M., M.M.E., '08. Asst. Prof. Exp. Eng. (2) and (3) Sibley College, Cornell Univ., Ithaca, N. Y. (1) 1018 E. State St., Ithaca, N. Y. A. S. M. E., Sigma Xi.
SAWERS, Edward Hayes, M.E., '10. 310 Pennsylvania St., Buffalo, N. Y.
SAWYER, Burton Mansfield, M.E., '92. 2517½ Trinity St., Los Angeles Cal.
SAWYER, Harland A., M.E., '90. Manager Elec. Light Co. (2) and (3) 60 Main St., Amesbury, Mass. (1) 4 Whittier St., Amesbury, Mass. N. E. L. A.
SAWYER, Harold Moore, '11. (1) 129 15th St., Wheeling, W. Va. (2) Wheeling Elec. Co., Wheeling, W. Va. A. I. E. E.
SAYCE, Archibald Herbert, M.E., '05. Continental & Commercial Bank Bldg., Chicago, Ill. 175 W. Jackson Blvd., Chicago, Ill.
SAYLE, Walter Chester, '10. Cleveland Punch & Shear Works. Cleveland, O.
SAYLES, Myron Edward, M.E., '08. 134 Appleton Ave., Pittsfield, Mass.
SAYLES, Robert Wilson, '97. 220 Broadway, New York City.
SAYRE, Leslie Albert, M.E., '13. Glenbrook, Conn.
SCARBOROUGH, Henry, jr., '11. Windermere Hotel, Chicago, Ill.
SCARR, John, jr., M.E., '05. 406 Union Ave., Paterson, N. J.
SCATTERGOOD, Ezra Frederick, M.M.E., '99. Cons. Elec. Engr., Dept. of Owens River Aqueduct, Pasadena, Cal.
SCIDMORE, Frank Lincoln. Address unknown.
SCHAAF, Albert Herman, M.E., '06. N. Amer. Bank Bldg., Ft. Wayne, Ind.
SCHAEDLE, Charles Andrew, M.E., '07. 46 Chestnut St., Crafton, Pa.
SCHAEFER, Cuthbert, M.E., '94. 1156 1st Natl. Bank Bldg., Chicago, Ill.
SCHAEFER, Jos. Harvey, '07. N. Y. Telephone Co., Equipment Engr., Syracuse, N. Y. (2) 321 Montgomery St., Syracuse, N. Y. (1) and (3) 256 Primrose St., Syracuse, N. Y. A. A. S. R., O. E. E.
SCHAPIRO, Samuel Hyman, '08. 917 E. Pratt St., Baltimore, Md.
SCHARPS, Albert Turner, LL.B., '98, M.E., '98. 74 Broadway, New York City.
SCHARTEL, Lyle Thomas, M.E., '17. 912 N. 11th St., Reading, Pa.
SCHEIBLE, Albert, M.E., '89. 79 W. Monroe St., Chicago, Ill. 1012 Rector Bldg., Chicago, Ill.
SCHEIBNER, Frederick William, M.E., '02. 933 Boulevard, Detroit, Mich.
SCHELLENTRAGER, Jacob Homer, '14. Care Jones & Laughlin Steel Co., Pittsburgh, Pa.
SCHELLINGER, Alfred Kirk, '09. De Ruyter, N. Y.
SCHENCK, Leon Horace, M.E., '00. Principal Technical High School, (2) Schenectady, N. Y. (1) and (3) Route 49, Schenectady, N. Y.

SCHENCK, Paul Albert, M.E., '07. 1012 Rutger St., Utica, N. Y.

SCHEU, Edward Magnus, '13. (2) and (3) Empire Powder Corp. 30 W. Main St., Le Roy, N. Y. (1) 33 Vernon Place, Buffalo, N. Y.

SCHICKEL, Norbert Henry, M.E., '09. 94 Forest St., Stamford, Conn.

SCHIELE, Arthur Roland, '11. 5620 Quinby St., Cleveland, O.

SCHIEREN, George Arthur, M.E., '00. (1) Great Neck, Long Island, N. Y. (2) and (3) Vice-Pres. Chas. A. Schieren Co., 38 Ferry St., New York City.

SCHIFF, Martin, M.E., '12. 155 Dickson Ave., Mansfield, Ohio.

SCHIVELY, Yale Roots, M.E., '17. Connersville, Ind.

SCHLEMMER, M.E., '03. 1811 Linn St., Cincinnati, O.

SCHLOSSER, Frederick Grant, M.E., '89. Ironton, O.

SCHLESINGER, Edwin James, '09. 306 W. 99 St., New York City.

SCHLUDERBERG, Christian, M.E., '11. 413 3d St., Highlandtown, Md.

SCHLUDERBERG, Carl G., '02. Asst. to Mgr., Detail & Supply Dept., (2) Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. (1) and (3) 210 N. Craig St., Pittsburgh, Pa. A. I. E. E., N. E. L. A., A. E. R. A., Am. Electrochemical Soc.

SCHMID, Robert Major, M.E., '07. 23 Beekman Pl., New York, N. Y.

SCHMIDT, Clarence Woodbridge, M.E., '17. Care Des Moines St., Ry. Co., Des Moines, Ia.

SCHMIDT, George John, M.E., '07. 901 James St., Wilkinsburg, Pa.

SCHMIDT, Will Armin, '90. Ilion, N. Y.

SCHNEIDER, Frederick Dahle, '06. 9 Beechwood Pl., Elizabeth, N. J.

SCHNEIDER, Herbert Collins, M.E., '17. 2932 14th St. N. W., Washington, D. C.

SCHNEPEL, John Henry, M.E., '95. 3 Livingston Ave., White Plains, N. Y.

SCHOENBORN, Henry Francis, jr., '95. 1359 Harvard St., Washington, D. C.

SCHOELLKOPF, Walter Horton, '08. 864 Delaware Ave., Buffalo, N. Y.

SCHOENBECK, Oscar Carl, '05. 809 Lake Blvd., St. Joseph, Mich.

SCHOENBORN, William Robert, '05. 329 Main St., Hackensack, N. J.

SCHOENIJAHN, Robert Polk, '06. Timmis & Chapman. (2) and (3) 315 Fifth Ave., New York City. (1) 12 Riverside Rd., Cranford, N. J.

SCHOFF, Albert Lawrence, '14. B.A. 17th and Sedgely Ave., Philadelphia, Pa. 3418 Baring St., Philadelphia, Pa.

SCHOFF, Harold Kent, '08. (1) Bala, Pa. (2) Care Stow Flexible Shaft Co., Bala, Pa. (3) 26 and Callowhill Sts., Philadelphia, Pa.

SCHOLES, Daniel Ransom, M.E., '04. 718 N. Elmwood Ave., Oak Park, Ill.

SCHOTTA, John Alfred, M.E., '12. (2) Care Goodyear Tire and Rubber Co., Akron, O. (1) 271 Arch St., Akron, O.

SCHRADER, Alvin Charles, M.E., '14. Graduate Student, Univ. of Mich. (3) 1007 E. Huron St., Ann Arbor, Mich. (1) 706 Wash. Ave., Dunkirk, N. Y.

SCHREINER, Charles Arman, jr., '01. Kerrsville, Texas.

SCHROEDER, William Emerson, '94. Wholesale Shoes. (1) 2335 Scottwood Ave., Toledo, O. (2) and (3) Sec. The Western Shoe Co., Toledo, O. Toledo Yacht Club, Inverness Yacht Club, Toledo Commerce Club, Toledo Tennis Club.

SCHROETER, Edward Joseph, '14. (1) 3054 Edgehill Rd., Cleveland Heights, Ohio. (2) and (3) Jordan Motor Car Co., Cleveland, O. A. S. M. E., S. A. E.

SCHROTT, C. C., M.E., '02. Asst. Supt. of Shops. (1) Iron Mt. Railway Shops, Gowanda, N. Y. (2) and (3) Iron Mts. Railway Shops, Argenta, Ark.

SCHROTT, John B., M.E., '04. Treasurer Hayes Machy. Co., Marshall, Tex.

SCHUERR, Gordon Leroy, '10. Winton, Pa.

SCHULTE, Max John Lacy, '15. (2) and (3) Care Combustion Engr. Corporation, 11 Broadway, New York City. (1) 67 Oak St., Ridgewood, N. J. A. S. M. E., Jr.

SCHULTHEIS, Leopold, '08. 125 75 St., Brooklyn, N. Y.

SCHULTZ, Andrew Schultz, M.E., '09. Plant Engineer, Bell Tel. Co. of Pa. Harrisburg, Pa.

SCHUM, Charles Henry, '95. Secretary Burke Electric Co. (2) and (3) Care Burke Elec. Co., 12th and Cranberry Sts., Erie, Pa. (1) 723 W. 10th St., Erie, Pa. A. I. E. E.

SCHUYLER, Hender Clarke, M.E., '10. Estimator with Selden Breck Con. Co. (2) and (3) 1108 Fullerton Bldg., St. Louis, Mo. (1) 5255 Von Versen, St. Louis, Mo.

SCHWAB, Florance Joseph, M.E., '03. (2) and (3) Care New Orleans Ry. Co., Engr. Dept., 201 Baronne St., New Orleans, La. (1) 3709 S. Franklin St., New Orelans, La. Univ. Club, La. Engrg. Soc.

SCHWARTZ, Frank Herbert, '06. 167 Terry St., Lawrence, Mass.

SCHWARTZ, Samuel Robert, M.E., '06. Address unknown.

SCHWARTZ, Otto, M.E., '05. 1472 State St., New Orleans, La.

SCHWARZ, J. Walter, M.E., '07. Asst. to Elec. Eng. (2) and (3) Care U. S. Light & Heat Corp., Niagara Falls, N. Y. (1) Orpheum Bldg., Niagara Falls, N. Y.

SCHWARZ, Ralph Carl, M.E., '08. 70 Normandy Ave., Rochester, N. Y.

SCOFIELD, Herbert H., '05. Asst. Prof. Materials of Eng. (2) and (3) Purdue University, West Lafayette, Ind. (1) 625 Russell St., West Lafayette, Ind. Am. Soc. Testing Matls., Ind. Engrg. Soc. Internatl. Soc. Testing Matls.

SCOFIELD, Hervey Noble, '09. Box 232, Mohawk, N. Y.

SCOTT, Alvah Alison, M.E., '08. Hilo, Hawaii.

SCOTT, Charles Ralph, M.E., '00. Tel. Engr., N. Y. Tel. Co. (2) 18 Cortland St., New York City. (1) 212 Bidwell Ave., W. New Brighton, N. Y.

SCOTT, Irwin, '11. General Contractor. (2) and (3) 268 Market St., San Francisco, Cal. (1) 1155 Leavenworth St., San Francisco, Cal.

SCOTT, James H., M.E., '08. Chemical Engineer. (2) and (3) Am. Lead Pencil Co., Hoboken, N. J. (1) 959 Angeligue St., North Bergen, N. J. A. C. S.

SCOTT, Harry Horsley, '04. Clay et Laguna St., San Francisco, Cal.

SCOTT, Laurence Irving, M.E., '99. (1) Burlingame, San Mateo County, Cal. (2) and (3) Royal Insurance Bldg., San Francisco, Cal. Burlingame Country Club, Pacific Union Club.

SCOTT, Peter Mac Gregor, '13. Central Ave., Far Rockaway, N. Y.

SCOTT, Philip Lane, '15. 630 N. Broadway, Yonkers, N. Y.

SCOTT, Warren Randolph, M.E., '14. With Steam and Sanitary Eng. Dept (2) 130 W. Frick Bldg., Pittsburg, Pa. (1) and (3) 340 S. Highland St., Pittsburgh, Pa.

SCOULER, Gavin Theodore, '09. Address unknown.

SCOVILLE, Henry Foster, '06. New Canaan, Conn.

SEACORD, Andrew W., M.E., '09. Master Mech. (1) 20 Vista St., Auburn, N. Y. (2) Inter Nat'l Harvester Co., Auburn, N. Y. (3) 20 Vista St., Auburn, N. Y.

SEAMON, Henry Lewis, M.E., '09. (1) and (3) Wantagh, L. I., N. Y. (2) Care Vapor Vacuum Heating Co., 47 W. 34th St., New York City.

SEAMAN, Dwight Scott, '13. 512 5th Ave., Clinton, Ia.

SEAMAN, Harry John, jr., '12. Care Bethlehem Steel Co., S. Bethlehem, Pa.

SEAMAN, Howard Lobdell, M.E., '09. Asst. Secy., Lobdell Car Wheel Co. (1) (2) and (3) 1603 Rodney St., Wilmington, Del. Rotary Club, Eng. Soc. of Delaware.

SEARCY, James Thomas, jr., '95. 304 S. 4th St., Columbus, Miss.

SEARLES, Harold Napton, M.E., '17. 145 N. Arlington Ave., East Orange, N. J.

SEARS, Frank Martin, M.E., '05. Treas., Holyoke Steam Boiler Wks. 23 Fairfield Ave., Holyoke, Mass.

SEAVY, Haller David, '01. 5 Ohio St., Bangor, Me.

SEE, Howard, M.E., '09. The Adolphus, Dallas, Texas.

SEELBACK, Herman, '03. Hamburg, N. Y.

SEELEY, De Forest H., M.E., '13. Mech. Engr. (1) and (3) Painted Post, N. Y. (2) Care Ingersoll Rand Co., Painted Post, N. Y.

SEELEY, Harold K., M.E., '10. Asst. Supt. United Gas Improvement Co. (2) and (3) 1931 S. 9th St., Philadelphia, Pa. (1) 121 S. 51st St., Philadelphia, Pa. Am. Gas Inst.

SEELY, Charles Alfred, M.E., '04. Spencer, N. Y.

SEEP, Albert H., '95. Vice-Pres. Mine & Smelter Supply Co. (2) and (3) 17th and Blake Sts., Denver, Col. (1) 1600 E. Colfax Ave.

SEAGLOWITZ, Oscar, M.E., '12. Factory Supt. (2) and (3) Ordinator Co. 323 East 34th St., New York City. (1) 336 Sackman St., Brooklyn, N. Y. A. S. M. E.

SEIBERT, Edwin William, M.E., '17. North Branch Y. M. C. A. 1013 W. Lehigh Ave., Philadelphia, Pa.

SEITZ, Frederick Gallagher, '05. 405 Grand St., S. Lansing, Mich.

SEIX, Juan, jr., M.E., '98. 10 Mendez Vigo, Ponce, P. R.

SEKIGUCHI, Yaekiche, M.E., '03. 20 Mita Koyomocho, Shiba Ku, Tokio, Japan. 4 Shinboricho, Azabaku, Tokio, Japan.

SELLING, Henry Monroe, M.E., '13. Snow Steam Pump Works, Pittsburg, Pa.

SEMON, William Hart, '05. (1) 1897 E. 89 St., Cleveland, O. (2) and (3) Garfield Bldg. Co., Cleveland, O.

SENIOR, Thomas King, '11. (1) 1643 Holywood Rd., Cleveland, O. (2) and (3) 1015 E. 130 St., Cleveland, O.

SERAT, Mortimer Edgerton, '82. Address unknown.

SERRELL, Ernest, '04. Address unknown.

SERRELL, John J., M.E., '10. Vice-Pres. and Sec. Smith-Serrell Co., Inc. (2) and (3) 90 West St., New York City. (1) 36 King St., Elizabeth, N. J.

SERRELL, William Calder, '97. Address unknown.

SETNA, J. A., '14. 52 Rue Lafette, Paris, France.

SEVERANCE, Charles Henry, '11. P. A. and Office Mgr. (2) and (3) 308–12 Penn. Ave., Scranton, Pa. (1) 1219 Schlager Blvd., Scranton, Pa.

SEWA, Adams Amos, '93. North Industry, O.

SEWALL, Henry Foster, '97. 80 Maiden Lane, New York City.

SEWARD, Fred William, '09. 1209 Hoolins St., Baltimore, Md.

SEYFANG, William George, M.E., '09. D. S. Morgan Bldg., Buffalo, N. Y.

SEYMOUR, Arthur George, '00. 105 E. 29 St., New York City.

SEYMOUR, Charles Kinne, M.E., '03. 600 W. 116 St., New York, N. Y.

SEYMOUR, Charles Mason, '05. 4642 Ellis Ave., Chicago, Ill.

SEYMOUR, John Porter, '92. Ogdensburg, N. Y.

SEYMOUR, Ralph Lincoln, M.E., '13. Trumbull Elec. Mfg. Co., Plainville, Conn.

SEYMOUR, Ralph Crysler, '84. Larchmont Manor, New York City.

SHACKFORD, James Murray, '76. 427 Olive St., Scranton, Pa.

SHAFER, William Bell, jr., M.E., '98. 105 W. 40 St., New York, N. Y.

SHALDERS, Robert James, M.E., '04. Commission and Consignment House, Rua Uruguayana 41, Rio de Janeiro, Brazil. Calixa 356, Rio de Janeiro, Brazil, S. A.

SHALLCROSS, Warren Mims, '06. Sec. and Treas. Yagle Motor Car Co. (1) Owen Hill Apts., Louisville, Ky. (2) and (3) 1529 S. 3d Ave., Louisville, Ky.

SHAMBERG, Herbert Douglas, M.E., '12. 52 W. 69 St., New York, N. Y.

SHAMBERGER, John Paul Lynas, M.E., '12. Parkton, Md.

SHANNON, Frank Joseph, M.E., '10. 312 Warburton Ave., Yonkers, N.Y.

SHAPIRO, Nathaniel, AB., '13. 906 S. 60th St., Philadelphia, Pa.

SHAPLEIGH, William C., M.E., '91. Pres. and Gen. Mgr. (2) and (3) Shapleigh-Wright Co., Lockport, N. Y. (1) Lockport, N. Y.

SHARP, Harry L., '08. Chief Draftsman, Niag. Lockport-Ontario Power Co. (2) 1642 Marine Bank Bldg., Buffalo, N. Y. (1) and (3) R. F. D., Hamburg, N. Y. A. I. E. E., N. E. L. A.

SHARP, Herbert Medell, M.E., '15. Instructor Sibley College, Franklin Hall, Cornell Univ., Ithaca, N. Y. (1) 339 15th St., Buffalo, N. Y. (2) and (3) 224 Linden Ave., Ithaca, N. Y. Tau Beta Pi, Eta Kappa Nu A. I. E. E.

SHARPE, James Marion, '09. 241 Washington St., Geneva, N. Y.

SHAW, Archibald Robert, '10. 45 W. 81 St., New York City.

SHAW, Charles Perrin, '05. 115 Erskine Ave., Detroit, Mich.

SHAW, George Bradstreet, '08. 637 Railway Exchange, Chicago, Ill.

SHAW, Horace Wright, '15. 444 Norwood Ave., Buffalo, N. Y.

SHAW, James Cicero, M.E., '04. Engineer. (2) and (3) Care Wm. Cramp & Sons, Shipbuilding Co., Philadelphia, Pa. (1) 6712 N. 7th St., Philadelphia, Pa. A. S. M. E., A. S. N. E.

SHAW, Joseph Deity, M.E., '04. Hondo, Tex.

SHAW, Joseph Henry, M.E., '12. R. F. D. 1, Edgemoor, Del.

SHAW, Norman Lowrie, M.E., '05. 568 Orchard Ave., Bellevue, Pa.

SHAW, Sylvester Edward, M.E., '15. (1) 61 Grove St., Tonawanda, N. Y. (2) and (3) Export Dept., National Roofing Co., Tonawanda, N. Y.

SHAW, William Francis, '04. (2) and (3) Chief Eng. and Gen. Mgr., American Rio Grande Land & Irrigation Co., Mercedes, Texas. (3) Mercedes, Texas. A. S. M. E., Phi Beta Kappa, Sigma Xi.

SHAYS, Wellington Barnes, M.E., '13. Campus Fire House, Reservoir Ave., Ithaca, N. Y.

SHARTLE, Robert Alexander, '92. Middletown, Ohio.

SHEA, Michael Bartholomew, E.E., '00. Address unknown.

SHEAFFER, J. G., M.E., '16.. 401 Audubon Ave., Wayne, Pa.

SHEAN, Arthur John, '11. 3 John St., Springfield, Mass.

SHEDDEN, John Stephen, M.E., '04. P. O. Drawer SS, North Yakima, Wash.

SHEFFER, John Wesley, M.E., '10. (1) and (3) 701 W. Front St., Berwick, Pa. (2) Elec. Engr., American Car & Foundry Co., Berwick, Pa. Amer. Inst. Elec. Engr.

SHELDON, Edwards Lyman, '98. Address unknown.

SHELDON, Fred, M.E., '11. Post & Sheldon Corp., Allentown, Pa.

SHELDON, James Henry, '90. Care U. S. Tire Co., 1790 Broadway, New York City

SHELLEY, Daniel, '75. Address unknown.

SHEN, Nye, M.E., '14. Peking-Mukden R.R. Co., Tangshan, China.

SHEPARD, Charles Dorman, M.E., '17. 115 34th St., Newport News, Va. A. S. M. E.

SHEPARD, Dwight Collins, '93. Medina, O.

SHEPARD, Edward Martin, M.E., '13. Firm member Little & Shepard. (2) and (3) 2033 Dime Bank Bldg. (1) 66 Borlingame Ave., Detroit, Mich.

SHEPARD, George Chapman, '89. 734 Roland Ave., Baltimore, Md.

SHEPARD, Geo. Hugh, M.M.E., '02. Syracuse Univ., Syracuse, N. Y.

SHEPARD, Geo. Rees, M.E., '96. 609 Jefferson Ave., Niagara Falls, N. Y.

SHEPARD, Louis Alfred, A.B., '92. M.E., '97. 2050 Grand Central Terminal Bldg., New York City.

SHEPARD, Leonard Griffin, M.E., '03. Controller. (2) Milwaukee Western Fuel Co., 14 Grand Ave., Milwaukee, Wis. (1) 593 Hackett Ave., Milwaukee, Wis.

SHEPARDSON, George D., M.E., '89. Prof. Electrical Eng. (2) and (3) Univ. of Minnesota, Minneapolis, Minn. (1) 717 E. River Road, Minneapolis, Minn. Nat. Elec. & Light Assn., A. I. E.E., I. E. S. S. P. E. E., Tau Beta Pi, Phi Beta Kappa.

SHEPHERD, Alfred Willard, M.E., '07. 400 Broadway, New York, N. Y.

SHEPPARD, Joel Fithian, 2d, M.E., '07. Dover Mach. Works, Dover, N. H.

SHERMAN, John Harvey, A.B., '11. 11 R St., N. W., Washington, D. C.

SHERMAN, Mason Hall, '91. 1115 Marquette Bldg., Chicago, Ill.

SHERO, Alva Eugene, M.E., '10. 35 E. Main St., Fredonia, N. Y.

SHERWIN, D. G., '13. Suffield, Conn.

SHERWIN, John Hastings, M.E., '13. (1) 1543 High St., Denver, Col. (2) and (3) Colorado Power Co., Boulder, Colo.

SHERWOOD, Arthur H., '01. Manufacturer's Agent. (2) and (3) 52 Vanderbilt Ave., New York City. (1) Garden City, L. I., N. Y. Engrs. Club, New York City.

SHERWOOD, Carlyle Johnson, M.E., '00. Address unknown.

SHERWOOD, Mather W., M.E., '99. Mgr. Plant 2, Chicago Pneumatic Tool Co. (2) and (3) Franklin, Pa. (1) 1126 Liberty St., Franklin, Pa. A. S. M. E.

SHERWOOD, Ralph Hartley, M.E., '97. Danville, Ill.

SHICK, Henry Trevenen, M.E., '90. 413 Green Terrace, Reading, Pa.

SHIELDS, Samuel Shedd, '93. Leetonia, O.

SHIELDS, William Dickinson, M.E., '07. Edgeworth, Allegheny Co.,Pa.

SHILAND, Elmer James, '03. 280 Devonshire St., Boston, Mass.

SHILLING, David William, M.E., '12. 2202 Mt. Royal Terrace, Baltimore, Md.

SHIPMAN, Robert Lee, M.M.E., '04. 215 Dryden Rd., Ithaca, N. Y.

SHIRES, Henry Herbert, M.E., '08. 89 6th Ave., Troy, N. Y.

SHIRLEY, James Joseph, M.E., '03. 325 Central Bldg., Los Angeles, Cal.

SHIVE, Roland Percy, '96. Address unknown.

SHOOK, Raymond Calvin, '08. 1514 Belmont St., Youngstown, O.

SHOPE, Harry Stephenson, M.E., '08. 1239 Market St., Harrisburg, Pa.

SHORT, Frank, M.E., '13. Instructor in Elec. Eng. (2) and (3) Eng. Bldg. U. of P., Philadelphia, Pa. (1) Penn Yan, N. Y. (3) 224 Buckingham Place, Philadelphia, Pa. A. I. E. E., Am. Electrochem. Soc., Int. Eng. Congress.

SHORT, Henry Morrison, '09. 327 Main St., Penn Yan, N. Y.

SHORT, Stanley, M.E., '08. Mercer Works, Am. Sheet & Tin Plate Co., Farrell, Pa. Clifton Springs, N. Y.

SHULL, Clare Orris, M.E., '17. Guilford Apts., Baltimore, Md.

SHULL, Fred Grover, M.E., '07. Asst. Mgr., Boston office Aluminum Co. of America. (2) and (3) 131 State St., Boston, Mass. (1) 109 Main St., Concord, Mass. A. I. E. E., Boston City Culb, Concord Country Club.

SHULTS, Leo John, M.E., '09. (1) and (3) 4819 Hutchinson St., Chicago, Ill. (2) International Harvester Co., Chicago, Ill. A. S. M. E.

SIBERT, Harold Ward, M.E., '14. 103 McGraw Pl., Ithaca, N. Y.

SIBLEY, Samuel Dunham, M.E., '07. Semet Solvay Co., Detroit, Wis.

SIBLEY, Walter Adelbert, '06. 500 Diversey Parkway, Chicago, Ill.

SIBSON, Horace Evans, M.E., '03. Box 159, Cynwyd, Pa.

SIBSON, Walter W., E.E., '93. Sec. and Treas., Phil. Drying Machinery Co. (2) and (3) 6721 Germantown Ave., Philadelphia, Pa. (1) 338 Gowen Ave., Mt. Airy, Philadelphia, Pa.

SICKLES, Eugene Charles, M.M.E., '98. Hyatt Roller Bearing Co., Harrison, N. J.

SICKLES, Edmund Southwick, '99. Address unknown.

SICHTERMANN, Arie John, '09. 1301 Green St., Philadelphia, Pa.

SIDLEY, Thomas Hill, M.E., '03. (1) 1142 Judson Ave., Evanston, Ill. (2) and (3) 1401 W. Jackson Blvd., Chicago, Ill.

SIDWAY, Clarence Spaulding, '98. Address unknown.

SIEBERT, William Paul, jr., '13. Phillips Sheet & Tin Plate Co., Hudson Term., Bldg., New York City.

SIEFKE, Frederick, '04. 231 72d St., Brooklyn, N. Y.

SILVA, Sebastian Diogenes, M.E., '12. Asuncion, Paraguay.

SILER, Laurence Norman, M.E., '15. 401 Dryden Rd., Ithaca, N. Y.

SILVERMAN, Harry Isaac, M.E., '12. 76 Manhattan Ave., Brooklyn, N. Y.

SIMMONS, Henry Gasset, '00. Green End, Newport, R. I.

SIMONDS, Edmund Franklin, '74. 132 Pleasant St., Fitchburg, Mass.

SIMONS, Henry Haverlock, '15. 40 Fargo Ave., Buffalo, N. Y.

SIMONS, Lloyd R., B.S.A., '11. Simonson Bldg., Mineola, N. Y.

SIMONS, William Butterfield, M.E., '12. 5750 Dorchester Ave., Chicago, Ill.

SIMONDS, Omar Howard, M.E., '08. (2) and (3) Mgr. Vicksburg Light & Traction Co. (1) 2120 Cherry St., Vicksburg, Miss.

SIMONTON, Ira Boyce, M.E., '06. 30 Church St., New York, N. Y.

SIMPSON, Dwight Swain, M.M.E., '07. Greytown, Saskatchewan, Can.

SIMPSON, Ernest Baker, '94. 13680 Terrace Rd., Cleveland, O.

SIMPSON, F. M., '14. 80 Hillyer St., E. Orange, N. J.

SIMPSON, Howard Sard, M.E., '96. Gas and Elec. Stove Salesman. (2) Rathbone Sard & Co., 1414 Wabash Ave., Chicago, Ill. (1) and (3) 508 W. 70th St., Chicago, Ill.

SIMPSON, Leroy, '94. Address unknown.

SIMPSON, William C., M.E., '10. 434 E. 7th St., Plainfield, N. J.

SIMPSON, William Jacob, '07. 470 Convent, New York City.

SIMPSON, William Robert, M.E., '93. 357 Park Ave., Yonkers, N. Y.

SIMSON, LeGrand De Graff, M.E., '11. 147 Delaware Ave., Tonawanda, N. Y.

SINCLAIR, Arthur Wells, M.E., '09. Care So. Cal. Edison Co., Redondo Beach, Cal.

SINGEWALD, Albert George, '99. Address unknown.

SINN, Bernhard Albert, M.E., '97. 12 E. 94 St., New York, N. Y.

SITTINGER, Rudolph Leonardt, '15. Sales Engineer. (1) 66 Mascot St., Dorchester, Mass. (2) and (3) 465 John Hancock Bldg., Boston, Mass.

SKINNER, Howard Albert, M.E., '10. 197 Shonnard Terrace, Yonkers, N. Y.

SKINNER, Luke L., '09. R. F. D. 2, Norwich, N. Y.

SKINNER, Robert Thompson, jr., '11. 116 W. 7th St., Cincinnati, O.

SKIPWITH, Lee, M.E., '10. Room 1346, 72 W. Adams St., Chicago, Ill.

SLADE, Foster Cornell, M.E., '97. New Canaan, Conn.

SLATER, Frederick Raymond, M.E., '94. Vice-Pres. and Gen. Mgr. Texas Power & Light Co. (1) 3825 Gillon Ave., Dallas, Tex. (2) and (3) 1521 Commerce St., Dallas, Tex. A. I. E. E., N. E. L. A., N. M. O., S. A. W.

SLAUSON, Henry Lewis, jr., M.E., '10. 506 Kelly St., Wilkinsburg, Pa.

SLAUSON, Harold Whiting, M.E., '07. 225 5 Ave., New York, N. Y.

SLAYMAKER, William Whitman, M.E., '12. Care Whitmer & Sons, 4600 Chester Ave., Philadelphia, Pa.

SLEETH, Montgomery, M.E., '06. 197 Rogers Ave., Bellevue, Pa.

SLITER, Harold Male, M.E., '08. 461 W. 1 St., Elmira, N. Y.

SLOAN, Augustus Kellogg, jr.,'09. 275 Washington Ave., Brooklyn, N.Y.

SLOAN, Ben, M.E., '07. Chicago Sales Mgr. (2) and (3) Pratt & Whitney Co., 12 N. Jefferson St., Chicago, Ill. (1) Pratt & Whitney, N. Washington, Chicago, Ill. A. S. M. E.

SLOAN, John Young, jr., '94. 42 13th St., Buffalo, N. Y.

SLOAN, Harry, E.E., '94. Address unknown.

SLOAN, William Griffith, M.E., '99. Vice-Pres. MacArthur Bros. Co., New York City. (2) and (3) 120 Broadway, New York City. (1) Nutley, N. J. A. S. C. E., Western Society Engrs., Engrs. Club.

SLOAT, Benjamin Crosby, '02. 415 W. 115th St., New York City.

SLOAT, Halbert Maitland, M.E., '04. Engineer and Rep. of Middletown Car Co. for Brazil. (1) (2) and (3) Rio de Janeiro, Brazil. C. C. 1634.

SLOCUM, Chester Arthur, M.E., '06. Consulting Eng. (2) 39 Cortland St., New York City. (1) and (3) 58 Chelsea Ave., Long Branch, N. J. A. S. M. E., A. S. Heating and Ventilating Engrs.

SLOCUM, Chester Colt, '07. Asst. Circuit Engr., Long Lines Dep t. A. T. & T. Co. (2) and (3) 195 Broadway, New York City. (1) 1743 Montgomery Ave., New York City.

SLOCUM, Leroy Morgan, jr., '11. Hardware business. (1) (2) and (3) Scottsville, N. Y. F. & A. M.

SLUTTER, Newton Waldron, '09. Address unknown.

SLUTZKER, Joseph, M.E., '03. Asst. Master Mechanic Penn. R. R. (2) Liberty and 28th St., Pittsburgh, Pa. Alder Court, Pittsburgh, Pa. (1) and (3) 1219 14th Ave., Altoona, Pa. Pgh. Alt and N. Y. R. R. Clubs.

SLY, Frederick Sanford, '07. Promotion Mgr., American Architect. (2) 50 Union Square, New York City. (1) and (3) 543 W. 162 dSt., New York City. A. S. M. E.

SMALLEY, Emerson, '99. 328 W. 57 St., New York City.

SMALTZ, John Condict, '15. 317 Midland Ave., St. Davids, Pa.

SMITH, Albert William, B.M.E., '78, M.M.E., '86. (2) Dean of Sibley College, Sibley College, Cornell Univ., Ithaca, N. Y. (1) 15 East Ave., Ithaca, N. Y. (3) Sibley College, Ithaca, N. Y. A. S. M. E.

SMITH, Albert Newton, '09. 514 Lake St., Elmira, N. Y.

SMITH, Arthur Sedwick Roberts, M.E., '95. 5848 Kenmore Ave., Chicago, Ill.

SMITH, Amzi, jr., '02. Care Watanga Elec. Co., Johnson City, Tenn.

SMITH, Barrett, M.E., '04. (1) Wellesley Hills, Mass. (2) and (3) 20 Central St., Boston, Mass.

SMITH, Bernard, M.E., '15. College Park, Ga.

SMITH, Benjamin Adams, M.E., '17. 1453 Elmwood Ave., Lakewood, O.

SMITH, Bronson Hasbrouck, '03. (2) and (3) Care Henry R. Kent & Co., 141 Broadway, New York City.

SMITH, Clifford Durand, M.E., '17. 715 Van Buren St., South Bend, Ind.

SMITH, Charles Henry, M.E., '85. Editor School Science and Mathematics Asst. Prin. Hyde Park, Chicago High School. (1) and (3) 5517 Cornell Ave, Chicago, Ill. (2) Hyde Park High School Chicago, Ill. Am. Physical Ass., A. A. A. & S.

SMITH, Charles Sumner, M.E., '09. Address Unknown.

SMITH, Charles Tenney, '96. 60 Morton St., Brooklyn, N. Y.

SMITH, Chas. Watt, M.E., '14. Efficiency Engr., Inspiration Consolidated Copper Co. (1) and (3) 707 W. 28th St., Los Angeles, Cal. (2) Box 324, Miami, Gila Co., Ariz. A. S. M. E.

SMITH, Donald Fuller, M.E., '13. (1) 2230 Lawrence Ave., Toledo, O. (2) Paddock Hodge Co., Toledo, O. Asst. Cashier.

SMITH, D. M., '14. 525 N. Broad St., Elizabeth, N. J.

SMITH, Dean Philip, '06. 100 Georgia St., Louisiana, Mo.

SMITH, Edwin D., '78. 1022 Liberty St., Franklin, Pa.

SMITH, Elwyn Lawrence, M.E., '17. L.C.Smith & Bros., Syracuse,N.Y.

SMITH, Edward Percy, '00. Wallace, Idaho.

SMITH, Irving Bell, '92. 1730 Erie Ave., Philadelphia, Pa.

SMITH, Edwin Kennedy, M.E., '06. Fort Monroe, Va.

SMITH, Frank Garretson, '08. Piano Mfg. (1) 558 Park St., Upper Montclair, N. J. (2) and (3) 774 Fulton St., Brooklyn, N. Y.

SMITH, Fred W., M.E., '08. Elec. Engr. (1) 520 E. Madison Ave., Springfield, O. (2) and (3) Care Robbins & Myers Co., Springfield, O. National Geographic.

SMITH, Frederick John, M.E., '16. 515 Madison Ave., Greenport, N. Y.

SMITH, George Oberst, '03. 114 Shelter St., Rochester, N. Y.

SMITH, Harold Babbitt, M.E., '91. Prof. of Elec.Eng. and Cons. Eng. (2) Worcester Polytechnic Inst., Worcester, Mass. (1) and (3) 20 Trowbridge Rd., Worcester, Mass. Sigma Xi, A. S. M. E., A. I. E. E., A. A. A. S.

SMITH, Howard Cook, M.E., '17. 993 Delaware Ave., Buffalo, N. Y.

SMITH, Harold Earle, '14. 371 Grand Ave., Brooklyn, N. Y.

SMITH, Harold Victor, '13. 58 Quincy St., Brooklyn, N. Y.

SMITH, Harold Whitmore, M.E., '08. 151 Collins St., Melbourne, Australia.

SMITH, Harry Edwin, '05. Care Amer. Loco. Co., Pittsburg, Pa. (1) 306 N. Tioga St., Ithaca, N. Y. (2) and (3) 916 Irwin Ave. N. S., Pittsburg, Pa.

SMITH, Harry E., M.E., '87. Prof. of Steam Engrg., College Station, Tex. A. S. M. E., S. P. E. E.

SMITH, Harry George, M.E., '06. 1500 Park Ave., Baltimore, Md.

SMITH, Harry James, M.E., '93. 1453 Elmwood Ave., Lakewood, O.

SMITH, Henry Pratt, M.E., '99. Apartado 55, Guanajuato, Mex.

SMITH, Herbert Hoffer, M.E., '16. 831 Ellicott St., Buffalo, N. Y.

SMITH, Howard Franklin, jr., '11. (1) 2204 Main St., Houston, Tex. (2) 806 Walnut St. (3) Box 688, Houston, Tex.

SMITH, Herman Carl, '03. Care Smith & Watson Iron Wks., Portland, Ore.

SMITH, Jay Lewis, A.B., '04. 700 Westinghouse Bldg., Pittsburg, Pa.

SMITH, James Lee., '96. Address not known.

SMITH, Irving Williams, M.E., '96. 420 East 125 St., New York City. A. I. E. E. Sec.

SMITH, Jesse Woodhull, E.E., '93. 420 E. 25th St., New York City.

SMITH, John B., jr., M.E., '03. 327 N. Main St., Plymouth, Pa.

SMITH, John Everett, M.E., '11. Co. de Real Del Monte y Pachuca, Pachuca, Hildago, Mex.

SMITH, Joseph Dickinson Clair, M.E., '03. Hartington, Neb.

SMITH, Joseph Hunt, MT., '13. Care Walter B. Smith, Barnesville, Ga.

SMITH, Julian Cleveland, M.E., '00. Vice-Pres. and Chief Engr. (2) Shawinigan Water & Power Co., Power Bldg., Montreal. (1) 314 Lansdowne Ave., Westmount, Que., Can. (3) 611 Power Bldg., Montreal. A. I. E. E. Can Soc. C. E., Brit. Inst. E. E., Engineers Club of Montreal, Engineers Club of New York.

SMITH, Lester Griffing, M.E., '95. Elec. Engr., Hudson & Manhattan R..R. Co. (1) Maplewood, N. J. (2) and (3) 137 Christopher St., New York City.

SMITH, Louis J., M.E., '99. Elec. Engr. (2) General Elec. Co., Pittsfield, Mass. (1) and (3) 68 Springside Ave., Pittsfield, Mass. A. I. E. E.

SMITH, Karl Wright, '15. Address unknown.

SMITH, Louis Lincoln, M.E., '90. (1) 111 Maple Ave., Edgewood Pk., Pittsburg, Pa. (2) and (3) Care Westinghouse Mach. Co., East Pittsburg, Pa.

SMITH, Mark Elmer, M.E., '06.. 246 W. 21 St., Erie, Pa.

SMITH, Norbury L., '97. Cohoes, N. Y.

SMITH, Percy James, E.S., '95. Pres. Smith Blank Book Co. (2) and (3) 75 Spring St., New York City. (1) 230 Riverside Drive, New York City.

SMITH, Peter, B.S., '00. 192 Elwood Ave., Newark, N. J.

SMITH, Robert Armstrong, '05. Pres. Smith-Serrell Co., Inc. (1) Mahwah, N. J. (2) and (3) 90 West St., New York City.

SMITH, RALPH BRADY, '07. Care The Western Tire Co., 2011 Michigan Ave., Chicago, Ill.
SMITH, ROYALL DIMOCK, '04. Address unknown.
SMITH, SIDNEY DAYTON, '72. (1) and (2) 27 Payne St., Hamilton, N. Y. (3) Smith Bldg., Hamilton, N. Y.
SMITH, THOMAS HORACE, '89. 1520 Cleveland Pl., Denver, Colo.
SMITH, WALTER, M.E., '09. 407 Kirkwood Blvd., Davenport, Ia.
SMITH, WILLARD DORSET, '13. 218 Granite Bldg., St. Louis, Mo.
SMITH, WILLIAM ARTHUR, '03. (1) 401 7th St., Barberton, O. (2) and (3) Ohio Insulator Co., Barberton, O.
SMITH, WILLIAM GRISWOLD, M.E., '92. Asst. Prof. Machine Design. (2) and (3) Armour Inst. of Tech., Chicago, Ill. 6758 Perry Ave., Chicago, Ill. 2300 Federal St., Chicago, Ill. S. P. E. E.
SMITH, WILLIAM MCALLISTER, M.E., '98. Telephone Engineer. (2) and (3) 463 West Street, New York City. (1) 104 Woodland Ave., New Rochelle, N. Y.
SMITH, WILLIAM NACE, B.M.E., '74. Sec. of Arkella Smith's, Canajoharie, N. Y.
SMITH, WILLIAM NELSON, M.E., '90. Efficiency Eng. American Agricultural Chemical Co., 92 State St., Boston, Mass. A. I. E. E., Am. Elect. Ry. Eng. Assn., Tau Beta Pi.
SMITH, WILLIAM SUMNER, M.E., '92. Care F. S. Payne Co. Richdale Ave., Cambridge, Mass.
SMITHERS, CHARLES, '96. 44 Exchange Pl., New York City. White Plains, N .Y.
SMITHERS, HERBERT, '10. 129 Berkeley Pl., Brooklyn, N. Y.
SMITHERS, SYDNEY COMMINS, '10. Care Thomson Carrol Co., Cleveland, Ohio.
SMOOT, LLOYD DUVALL, '01. (2) and (3) Com. of Public Works, Engrs. Bldg., Jacksonville, Fla. (1) 1443 Laura St., Jacksonville, Fla.
SNELL, THOMAS CULLEN BRYANT, M.E., '93. 159 Johnson Ave., Newark, N. J.
SNIDER, WARNER GARFIELD, M.E., '06. 3206 Prospect St., Cleveland, O.
SNOW, BERT AUGUSTUS, '12. Univ. of Ariz., Tucson, Ariz.
SNOW, EDWARD JAMES, M.E., '04. 22 Forest St., Montclair, N. J.
SNOW, ERNEST ANSEL, '73. Manufacturer. High Point, N. C.
SNYDER, ALFRED, M.E., '07. Exec. Asst. Westinghouse E. & M. Co. (2) P. O. Box 911, Pittsburgh, Pa. (1) and (3) 1120 Ross Ave., Wilkinsburg, Pa.
SNYDER, CECIL DENISE, M.E., '13. Freehold, N. J.
SNYDER, FLOYD CHRISTIAN, M.E., '06. 111 Pine St., Massillon, O.
SNYDER, FRANK GEROME, M.E., '93, M.M.E., '94. R. F. D. 27, Newfield, N. Y.
SNYDER, HERBERT TURNER, M.E., '04. 2024 Linden Ave., Baltimore, Md
SNYDER, JAMES LAMBDIN, M.E., '13. (1) 1503 Cedar St. (2) and (3) With Allis-Chalmers Co., Milwaukee, Wis.
SNYDER, LEO HARTER, '06. Dept. Sales Manager. (2) Joseph Dixon Crucible Co., Jersey City, N. J. (1) and (3) 2815 Blvd., Jersey City, N. J. A. S. M. E.
SNYDER, OTTO VON SCHRADER, '10. Meterman, care The Pawtucket Elec. Co., Pawtucket, R. I.
SOMERBY, CHARLES THOMAS, '13. 319 Chili Ave., Rochester, N. Y.
SOMERVILLE, JOHN SNAPE, M.E., '07. (1) and (3) 1041 Michigan Ave., Evanston, Ill. (2) Care Hunter Walton & Co., Wholesale Commissioners, 35 W. Kinzie St., Chicago, Ill.
SOMERVILLE, WILLIAM ANDERSON SHIPMAN, '11. 100 Harrison St., Cumberland, Md.
SOMMER, KARL ERNEST, M.E., '96. 216 Oakdale Rd., Roland Park, Md.
SOMMERVILLE, RUFUS JOHN, '12. Depot Lane, New York City.
SOOKATSCHOV, PLATON WALDIMIR, '01. 18 Petrovsky, Kharcow, Russia.
SOUDER, CLEMENT F., JR., M.E., '16. Asst. Chief Engr. (2) and (3) Continental Sugar Co., Toledo, Ohio. (1) 2718 Hollywood Ave., Toledo, O.
SOUTH, FURMAN, JR., M.E., '12. Care Ritter Conley Co., 15 Maple Lane, Edgeworth, Pa.
SOUTHARD, GEORGE LEE, M.E., '01. Care U. S. Gypsum Co., 5th Ave. and Monroe St., Chicago, Ill.
SOUTHARD, HARRY ELLIS, M.E., '13. (1) 518 W. Pine St., Enid, Okla. (2) and (3) Care U. S. Gypsum Co., 203 W. Monroe St., Chicago, Ill.
SOUTHWELL, WILLIAM LEE, '05. Care Central Georgia Power Co., Macon, Ga.
SOUTHERLAND, FREDERIC JEWELL, '07. Address unknown.
SOUTHWICK, CHARLES, M.E., '13. 60 Ella St., Bloomfield, N. J.
SOWDON, WM. KENNETH, M.E., '11. Sales Engr., Shipley Const. & Supply Co. (1) and (3) 506 Warburton Ave., Yonkers, N. Y. (2) 66 Warren St., Brooklyn, N. Y.
SOWLES, LEWIS WILLIAM, '06. 309 S. Main St., Salt Lake City, Utah.
SPAIDE, ROLLAND LEE, M.E., '09. (1) and (3) Butler, Pa. (2) Spaide Shirt Co., Tyronne and Butler, Pa.
SPANOGLE, DONALD BARE, M.E., '07. Cynwyd, Pa.
SPATES, THOMAS GARDNER, M.E., '13. Engr. Central Sta. Industry. (3) and (2) 444 Jackson Ave., Long Island City, N. Y. (1) 33 E. Lincoln Ave., Mt. Vernon, N. J. N. E. L. A
SPEAR, LOUIS HOYT, '90. Perm. 82 Hoffman Ave., Columbus, O. Temp. San Pedro de la Frontera, Esb. de Salta, Argentina, S. A.
SPEED, LORNEZO DOWE, M.E., '05. 21 Hopper St., Utica, N. Y.
SPEIDEN, EBEN CHILDS, M.E., '04. Manufacturer. (1) and (3) The Lochiel, Niagara Falls, N. Y. (2) Acheson Graphite Co., Niagara Falls, N. Y. Am. Electrochemical Soc.
SPENCE, CARL CLEMENT, '01. Crystal Springs, Miss.
SPENCER, CLARENCE GARFIELD, M.E., '04. Chile Exploration Co., Tocopilla, Chile.
SPENCER, ELIOT LINN, M.E., '96. 905 E. 138 St., New York, N. Y.
SPENCER, GEORGE LAWTON, M.M.E., '07. 90 Keene St., Providence, R. I.
SPENCER, LESLIE VANDEFORD, M.E., '11. Free Press Bldg., 95 Fort St., W. Detroit, Mich.
SPENCER, RAYMOND, M.E., '13. Walnut Creek, Contra Costa Co., Cal.
SPENCER, OLIVER CHANCEY, M.E., '07. Centralia State Bank, New Washington Annex, Centralia. Seattle, Wash.
SPERLING, NATHANIEL JOSEPH, M.E., '98. Casino Beach, Astoria, L. I., N. Y.
SPERRY, EDWARD GOODMAN, M.E., '15. (2) and (3) Care Sperry Gyroscope Co., Brooklyn, N. Y. (1) 100 Marlborough Rd., Brooklyn, N. Y.
SPERRY, WILLIAM MILLER, 2D, LL.B., '12. 30 East 42 St., New York City.
SPICER, EDWARD DELANCY, M.E., '12. 68 W. 10 St., New York City.
SPIER, DANIEL RICHARD, M.E., '00. 330 Onondaga St., Syracuse, N. Y.
SPILLMAN, EDWARD ORTON, M.E., '97. N. Tonawanda, N. Y.
SPOEHRER, HERMANN, JR., M.E., '99. 5740 Julian Ave., St. Louis, Mo.
SPORBORG, HENRY NATHAN, M.E., '99. Holyrood, Hillimorton Rd., Rubgy, England.
SPOTSWOOD, DANDRIDGE, '97. 170 High St., Petersburg, Va.
SPRAGUE, FRANK DESMONDE, C.E., '11. (2) and (3) Care Eng. Dept., Sprague Cont. & Sig. Corp. (1) Yonkers, N. Y.
SPRANSY, BROWER COX, M.E., '14. Cutler Hammer Mfg. Co., 50 Church St., New York, N. Y.
SPRANSY, MILTON ROBERT, B.S., '15. 1304 Euclid St., Washington, D. C.
SPRECKLES, CHARLES HERMAN, M.E., '17. 710 Madison St., Brooklyn, N. Y.
SPRINGER, JOHN JACOB, M.E., '03. 743 Everett St., Cincinnati, O.
SPRONG, EDWARD ALBERT, JR., M.E., '17. 825 W. 180th St., New York City.
SQUIRE, WILLIAM HORACE, M.E., '97. Engr., Hotckiss & Cie. 6 Route de Gonesse, Saint Denis, Seine, France.
SQUIRES, HERBERT BRADSHAW, '96. Care Western Elec. Co., San Francisco, Cal.
SQUIRES, JESSE COX, '15. 256 E. 2d South St., Salt Lake City, Utah.
STAATS, EDWARD POMEROY, M.E., '05. Engrg. Asst., Eng. Dept., N. Y. Tel. Co. (2) 26 Cortlandt St., New York City. (1) and (3) 100 West 162d St., New York City. Tel. Soc.
STACK, ALVAN H., M.E., '14. 1373 Grant St., Denver, Colo.
STAFFORD, NORMAN LESLIE, JR., M.E., '11. 123 Stroud St., Canastota, N. Y.
STAHL, DAVID VINTON, M.E., '14. Philadelphia Gas Co. Philadelphia, Pa.
STAHL, EDWARD CANNING MÜHLENBUCH, M.E., '13. Draftsman, N. Y. C. R. R. (2) Eng. Dept., Grand Central Terminal, New York City. (1) and (3) 26 S. Highland Ave., Ossining, N. Y. N. Y. Electrical Soc.
STAHL, GUSTAV DAVID, M.E., '17. Berlin, N. H. A. I. E. E.
STALEY, LUCIEN HAMEN, '15. Address unknown.
STAMFORD, ALBERT, M.E., '99, M.M.E., '00. (1) and (3) Magnolia Ave. and Atlantic Blvd., Larchmont, Norfolk, Va. (2) Supt. U. S. Wood Preserving Co., Buell, Va.
STAMFORD, WILLIAM BOYD, M.E., '99. 201 Abbott Bldg., Philadelphia, Pa.
STANBROUGH, DUNCAN GOLDSMITH, M.E., '04. (3) and (1) 1302 E. Gr. Boulevard, Detroit, Mich. (2) Packard Motor Car Co., Detroit, Mich. A. S. M. E., Taylor Society, Wolverine Automobile Club, Masonic Fraternity.
STANDISH, FRANK BILLINGS, '99. 310 Elm St., New Haven, Conn.
STANLEY, CARL, M.E., '17. 51 Highland Ave., Buffalo, N. Y.
STANLEY, ROY MORGAN, M.E., '98. Address unknown.
STANION, GEORGE HENRY, M.E., '99. (2) Standard Underground Cable Co., 700 Westinghouse Bldg., Pittsburg, Pa. (1) and (3) 1203 Palo Alto St., Pittsburgh, Pa.
STANSEL, NUMAN REID, M.M.E., '03. Local Mgr., Southwest Gen. Elec. Co. (2) 500 San Francisco St., El Paso, Texas. (1) and (3) 1800 E. Nevada St., El Paso, Texas. Sigma Xi.
STANTON, CHARLES WEEMS, '07. Mobile, Ala.
STANTON, DONALD TENNYSON, '15. 195 Medbury Ave., Detroit, Mich. Dodge Bros.
STANTON, HAROLD OLIVER, M.E., '10. Cartridge Dept., Winchester Repeating Arms Co. 116 Mansfield St., New Haven, Conn.
STANWOOD, HENRY CHAPMAN, M.E., '13. 807 Maryland Trust Bldg., Baltimore, Md.
STAPLES, CHARLES WELLS, '11. Sanborn Hall, Franklin, N. H.
STARK, FREDERICK EDGAR, M.E., '12. Engrg. Dept., Commonwealth Edison Co.(2) Edison Bldg., Chicago, Ill. (1) 126 Vennum Ave., Mansfield, O. (3) 841 Holland Ave., Wilkinsburg, Pa.
STARKWEATHER, JOHN THAYER, '96. 247 Pawling Ave., Troy, N. Y.
STARKWEATHER, WILLIAM GUSTAVIUS, M.E., '92. New England Sales Manager. (2) and (3) 53 State St., Boston, Mass. (1) 17 Gibson St., Newtonville, Mass. A. S. M. E.
STARR, ALBERT BIRDSLEY, M.E., '07. East Hampton, Conn.
STARR, EVERETT GARRETT, '02. Address unknown.
STARR, ARTHUR, M.E., '06. Elec. Engr. 518 Academy Ave., Sewickley, Pa.
STARR, BENJAMIN FRANKLIN, 3d, M.E., '11. 21 N. Ferry St., Schenectady, N. Y.
STARR, CHARLES BOWMAN, M.E., '14. 518 Academy Ave., Sewickly, Pa.
ST. CLAIR, HOWARD GRYFFYTH, '09. Address unknown.
STEARNS, DAVID PYOTT, M.E., '05. 901 W. Jackson Blvd., Chicago, Ill.
STEARNS, ELLIS JOHNSON, M.E., '03. P. O. Drawer Box 840, New Orleans, La.
STEARNS, EMORY WARD, '02. Rubber Manufacturer. (2) and (3) 300 Shoffield Ave., Brooklyn, N. Y. (1) Roslyn, N. Y.
STEBBINS, E. VAIL, B.S., '93, M.E., '94, M.M.E., '95. Stock Broker. Member firm De Coppet & Doremus. (2) and (3) 42 Broadway, New York, N. Y. (1) 33 W. 9 St., New York, N. Y.
STEBBINS, WALTER WHITMAN, '97. Physician, Mount Vernon, Wis.
STEDMAN, IRVING LYNN, M.E., '01. Lake Placid, N. Y.
STEEL, WILLIAM FOSTER, M.E., '04. 415 Logan Ave., Milwaukee, Wis.
STEELE, EDWARD ALBERT, M.E., '06. Engr. Construction and Asst. Treas. (1) 1600 Arch St., Philadelphia, Pa. (2) 507 Westview Ave., German town, Pa. (3) 1600 Arch St., Philadelphia, Pa.
STEELE, WESLEY, M.E., '98. (1) and (3) 27 Cedar St., New York, N. Y. (2) 322 Highland Ave., Upper Montclair, N. J.
STEELE, WILLIAM FRANK, '96. Manufacturer. 79 Broad St., Gloversville, N. Y.
STEELQUIST, RUEBEN, M.E., '10. Local Mgr. Oregon Power Co. (2) 329 52d St., Corvallis, Ore. (1) and (3) 612 S. 4th St., Corvallis, Ore. N. E. L. A.
STEEN, CARL WALDEMAR, '08. Lassarsgade, Christiana, Norway.
STEEVER, JEROME ELWELL, '03. 51 Board of Trade, Chicago, Ill.
STEGE, ERNEST AUGUST, M.E., '90. Manufacturer. 256 W. Jefferson St., Louisville, Ky.
VON STEINWEHR, FRED, A.B., '07. (2) and (3) Supt. Queen City Printing Ink Co., Cincinnati, O. (1) Grandier Rd., Cincinnati, O.
STEPHENS, CHARLES WAINWRIGHT, M.E., '05. Care Detroit Twist Drill Co. 112 Pasadena Apts., Detroit, Mich.
STEPHENS, FLOYD C., M.E., '08. 130 Vermont St., Buffalo, N. Y.
STEPHENS, LEROY S., '16. Asst. Supt. (2) and (3) Stephens Adamson Mfg. Co., Aurora, Ill. (1) 70 N. View St., Aurora, Ill.
STEPHENS, GEORGE WASHINGTON, '88. Address Unknown.
STEPHENSON, HERMAN, M.E., '01. 132 E. Buffalo St., Ithaca, N. Y.
STEPS, ROBERT ALEXANDER, M.E., '11. 120 McClune Terrace, Ithaca, N. Y.
STERN, HAROLD GROSS, M.E., '06. Owner Harold G. Stern & Co. (2) and (3) 524 1st Ave. S., Seattle, Wash. (1) Endolyne, Seattle, Wash.
STERN, ISAAC, '97. (2) and (3) Care Michaels-Stern & Co. (1) 87 Clinton Ave., Rochester, N. Y.
STERN, JULIUS LONG, M.E., '13. Firm Isaac Long Dept. Store. (2) 17 Public Sq., Wilkes-Barre, Pa. (1) 327 S. River St., Wilkes-Barre, Pa. (3) Box 387, Wilkes-Barre, Pa.
STERNBERGER, ROBERT OSCAR, M.E., '17. Bloomfield, N. J.
STERNBERGH, JAMES HERVEY, JR., '13. Kansas City Bolt & Nut Co., Kansas City, Mo. (1) 509 Gladstone Blvd.
STEVENS, ALEXANDER C., M.E., '07. Instructor Elec. Eng. Cornell University. (2) Ithaca, N. Y. (1) and (3) 319 Mitchell St., Ithaca, N. Y. Eta Kappa Nu.
STEVENS, BYRON, M.E., '97. Schoharie, N. Y.
STEVENS, C. L., '16. 319 Jefferson St., Muskegon, Mich.
STEVENS, DOUGLAS F., M.E., '07. (2) Director, Sec. and Supt., Acme Brick Co. Care Acme Brick Co., Cayuga, Ind. (3) and (1) 507 Vermilion St., Danville, Ill.
STEVENS, FRED PARK, M.E., '96. Address unknown.
STEVENS, FREDERICK MORRIS, '74. Manufacturer. (1) 225 West End Ave., New York City. (2) 89 Cliff St., New York City. (3) 225 West End Ave., New York City. Cornell Club, Amateur Billiard Club of N. Y., Masonic, I. O. O. F., Pat. and Founders of Am.

STEVENS, Harold Gregory, M.E., '13. Curtis & Co., Mfg. (2) and (3) 5612 Julian Ave., St. Louis, Mo. (1) 1st Ave., Seymour, Conn.

STEVENS, Harold Luther, '95. Dist. Sales Mgr., Lock Steel Co. (2) 40 Central St., Boston, Mass. (1) and (3) 46 Arlington St., Newton, Mass.

STEVENS, Harold Wait, M.E., '14. (2) and (3) 39 Boylston St., Boston, Mass. (1) Columbia Ave., Pittsburgh, Pa.

STEVENS, Wm. Clifford, M.E., '06. Dist. Sales Mgr., Cutler Hammer Mfg. Co. (2) and (3) 50 Church St., New York City. (1) 67 Tulip St., Summit, N. J. A. I. E. E.

STEVENSON, Joseph Welch, M.E., '01. 3064 Bailey Ave., New York City.

STEVENSON, William Mills, '10. (1) 14 Fifth Ave., New York, N. Y.

STEVICK, Crist Harvey, '03. Member, Eng'g Corps, Gas Co. Ravenswood, New York City.

STEWART, Arthur Daniel, M.E., '91. Anchor, Ill.

STEWART, Arthur Lawrence, M.E., '09. Designer. (2) Gleason Works Rochester, N. Y. (1) and (3) 1167 Park Avenue, Rochester, N. Y. S. A. E.

STEWART, Donald, M.E., '08. Baton Rouge Elec. Co. (1) (2) and (3) Baton Rouge, La.

STEWART, Elliot, '11. Address unknown.

STEWART, Fenwick Joseph T., M.E., '93. 46 Cedar St., New York, N. Y.

STEWART, Fred Ventina, '04. 2431 Michigan Ave., Chicago, Ill.

STEWART, George Robinson, '06. Care Riter-Conley Mfg. Co., Pittsburg, Pa.

STEWART, Homer Edgar, jr., M.E., '09. 158 Park Ave., Warren, O.

STEWART, John Wesley, M.E., '14. Care Adjutant General, Washington, D. C. 66 Walker Ave., Bradford, Pa.

STEWART, Ralph Berry, M.E., B.S., '17. Pelzer, S. C.

STEWART, Sidney VanDerWeer, M.E., '07. Care Ajax Iron Wks. Corry, Pa.

STICHT, Arthur Christopher, M.E., '96. Canajoharie, N. Y.

STICKNEY, George Hoxsie, M.E., '96. Ill. Eng., Asst. to Sales Mgr. (2) Edison Lamp Wks. of the Gen. Elec. Co., Harrison, N. J. (1) and (3) 5 Claremont Place, Montclair, N. J. Gen. Sec. A. I. E. E., N. E. L. A.

STIFEL, Arthur Clarence, '03. Mfg. 845 Main St., Wheeling, W. Va.

STILLMAN, Austin F., M.E., '07. Vice-Pres. and Sec. Watson Stillman Co. (2) P. O. Box 26, Roselle, N. J. (1) and (3) 45 Park Ave., Elizabeth, N. J. A. S. M. E.

STILLMAN, Chester Hastings, M.E., '96. 75 Pinewoods Ave., Troy, N. Y.

STILLMAN, Edwin Arthur, M.E., '08. Pres. Watson-Stillman Co., Roselle, N. J.

STILWELL, Richard Oakley, M.E., '95. Mgr., Lawrence Park Realty Co. Bronxville, N. Y.

STIMSON, Edward Albion, '11. 30 Myrtle Ave., Holyoke, Mass.

STIVERS, Francis Arthur, '13. 303 Bailey St., Chattanooga, Tenn.

ST. JOHN, Frank Lamar, jr., M.E., '15. 306 Bryant Ave., Ithaca, N. Y.

STOCKER, Samuel Charles, M.E., '10. Mishawka, Ind.

STOCKING, Albert Henry, M.E., '95. 5120 South Park Ave., Chicago, Ill.

STOCKING, Charles Francis, '97. 5037 Grand Blvd., Chicago, Ill.

STOCKING, Walter Henry, M.E., '15. Bethlehem Steel Co., Bethlehem, Pa. (2) and (3) 500 Broadhead Ave., Bethlehem, Pa. (1) 308 N. East St., Coudersport, Pa.

STOCKLY, George Jeffers, M.E., '12. Salesman, Bond Business. (2) 7 Wall St., New York City. (1) and (3) 1269 Madison Ave., New York City.

STOCKSTROM, Arthur Louis, M.E., '14. 3263 Hawthorne Blvd., St. Louis, Mo.

STOCKTON, W. S., M.E., '16. 356 Grove St., Chicopee Falls, Mass.

STOCKWELL, Walter Edward, M.E., '03. Myndus, N. Mex.

STODDARD, Allyn D., M.E., '16. Johns-Pratt Co., Hartford, Conn. 219 Laurel St., Hartford, Conn.

STODDARD, Chauncey, 3d, '07. 814 S. 10th St., Omaha, Neb.

STODDARD, John Williams, '12. (1) 72 Belmont Ave., Dayton, O. (2) Asst. Purchasing Agent, 92 State St., Boston, Mass. (3) 20 Edge Hill Rd., Brookline, Mass.

STODDARD, David Ayars, M.E., '08. 1417 Woodlawn Ave., Wilmington, Del.

STONE, Albert W., M.E., '04. Machy. Salesman. (2) Walter H. Foster Co., 50 Church St., New York City. (1) and (3) Union St., Plainfield, N. J. S. A. E.

STONE, Ira John, M.E., '16. Asst. to Mech. Engr., Maryland Plant, Bethlehem Steel Co. (1) and (3) Stag Hall, Sparrows Point, Md. (2) Mech. Dept., Beth. Steel Co., Sparrows Pt., Md.

STONE, G. L., M.E., '16. 320 N. Aurora St., Ithaca, N. Y. (1) Utica, N. Y. A. S. M. E.

STONE, M. W., M.E., '14. Y. M. C. A., Detroit, Mich.

STONE, R. L., M.E., '07. Dupont Powder Co. 313 W. 19 St., Wilmington, Del.

STOODART, D. A., M.E., '08. 1417 Woodlawn Ave., Wilmington, Del.

STORER, L., M.E., '08. Care J. Menzo Storer, Morton, Orleans Co., N. Y.

STORM, Walter Woolsey, M.E., '08. Supt. Wilmington Iron Works. Wilmington, N. C. Box 197, Wilmington, N. C. 316 Ann St., Wilmington, N. C.

STORY, John Henry, '91. Bayside, L. I., N. Y.

STOTHOFF, William Stewart, '97. Gen. Supt., Wm. Wharton Jr. & Co. Also Gen. Supt. Tioga Steel & Iron Co., Philadelphia, Pa. (2) and (3) Easton, Pa. (1) Paxinosa Ave., Easton, Pa.

STOTZ, John Jennings, M.E., '16. 51 Afton Ave., Crafton, Pa. Tau Beta Pi, A. I. E. E., A. K. N.

STOTZ, J. K., M.E., '16. Care Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

STOWELL, William Mix, B.M.E., '85. 412 Decatur St., Decatur, Ill.

STOWELL, William Stuart, M.E., '07. (1) and (3) 200 W. 92 St., New York, N. Y. (2) Care Westinghouse, Church, Kerr & Co., 37 Wall St., New York City.

STRASSBURGER, Edgar, M.E., '96. (1) 354 Central Park W., New York City. (2) and (3) Gen. Supt., Standard Underground Cable Co., Ltd., Hamilton, Ont., Canada. Assoc. Member A. I. E. E.

STRATFORD, Frank Burnette, M.E., '95. Mech. Engr. and Mfgr., Franklin Paper Mills Co. 160 Comelson Ave., Jersey City, N. J.

STRATTON, Harry Frost, '03. (1) and (3) 2698 E. 79th St., Cleveland, O. (2) Elec. Controller & Mfg. Co., Cleveland, O.

STRATTON, Julian A., E.E., '04. Telephone Engineer. (2) and (3) Western Elec. Co., Chicago, Ill. (1) 5025 W. 23d St., Cicero, Ill.

STRATTON, Milton Greene, '91. Elec. Engr., Sanderson & Porter, 52 William St., New York City.

STRAUCH, Albert Theodore, jr., M.E., '17. 25 W. 94th St., New York City.

STRAUS, Harry Cook, '97. Treas. Amer. Tin & Time Plate Co. (2) 2400 Vine St. (2) Philadelphia, Pa. (1) 4520 Locust St., Philadelphia, Pa.

STRAUS, William Rayner, M.E., '10. 1812 Eutaw Pl., Baltimore, Md.

STRAWBRIDGE, Russell E., M.E., '13. (1) 1617 Niagara Ave., Niagara Falls, N. Y. (2) and (3) American Cyanamid Co., Niagara Falls, Ont. Can.

STRAYER, Calvin John, '10. Address unknown.

STREET, George Tatum, M.E., '03. 171 E. College St., Oberlin, O.

STREETER, Stevens Dana, M.E., '96. Care T. Streeter, Tunkhannock, Pa.

STREHAN, George Earnest, '09. Address unknown.

STRICKLAND, Harold Allison, '07. 558 Cadillac Ave., Detroit, Mich.

STRICKLER, Lee Forney, '13. 150 Fair St., Paterson, N. J.

STRING, John Farson, '10. Mgr., Galey & Lard, 56 North St., New York, N. Y.

STROHM, Harold C., M.E., '12. Salesman, Am. Iron & Steel Mfg. Co. (2) and (3) 17 Battery Place, New York City. (1) 519 Deer St., Dunkirk, N. Y.

STRONG, Charles Henry, jr., '93. Gen. Mgr. Dept. Store. (1) Cleveland, O. (2) and (3) 630 Euclid Ave., Cleveland, O.

STRONG, Chester Liscom, M.E., '12. South Hadley Falls, Mass.

STRONG, Harry Merrill, M.E., '17. Willseyville, N. Y. Eta Kappa Nu.

STRONG, James Gregory, '06. Contractor. (2) and (3) 501 Sweetland Bldg., Cleveland, O. (1) 3147 Prospect Ave.

STRONG, Marvin Willis, M.E., '01. 1651 West St., Utica, N. Y.

STROTHER, Robert Henry, '01. Room 1805, 293 Broadway, New York City.

STROUD, Smith Leroy, '03. 811 Cedar Ave., Long Beach, Cal.

STRUCK, Henry Waldo, M.E., '13. 219 Harrison St., Davenport, Ia.

STRUCKMAN, George William, '15. 3421 Oak Park, St., Berwyn, Ill.

STRUVEN, Edward Dietrich, '01. 629 W. North Ave., Baltimore, Md.

STUART, Kenneth Emmons, M.E., '97. Chief Engineer, Internat'l Pneumatic Tube Co. (1) Baird Rd., Merion, Pa. (2) and (3) 926 Columbia Ave., Philadelphia, Pa.

STUBER, Adolph, M.E., '12. 1290 Lake Ave., Rochester, N. Y.

STUDE, Alphonse Jerome, M.E., '11. (3) 907 Congress Ave., Houston, Tex.

STUEBLING, Albert Fredricks, '11. General Foreman, Mech. Dept. R. I. Lines. (2) Care M. M. R. I. Lines, Amarillo, Tex. (3) 2099 E. Fillmore St., Amarillo, Tex. (1) 47 Farmington St., S. Hadley Falls, Mass.

STULL, Charles Rodman, M.E., '07. Kingston Gas & Elec. Co., Kingston, N. Y.

STURDEVANT, Chas. R., M.E., '92. Educational Director, Am. Steel & Wire Co. (2) and (3) 94 Grove St., Worcester, Mass. (1) Holden, Mass. A. I. E. E.

STURGES, Harold Alexander, M.E., '08. R. F. D. 6, Fairfield, Conn.

STURGE, John Howard, '08. Address not known.

STURGIS, Raynor Francis, M.E., '10. Box 141, Morris Plains, N. J. (Same as Morristown.)

STURGIS, William Bayard, M.E., '08. John Hopkins Univ., Baltimore, Md.

STURMFELSZ, George John, jr., M.E., '13. Asst. Supt. Boilers. (1) and (3) 2820 E. Monument St., Baltimore, Md. (2) Du Pont Powder Co., Du Pont Hotel, City Point, Va. A. S. M. E.

STURROCK, James F., jr., M.E., '13. Care Ingersoll Rand Co., 705 N. Main St., Athens, Pa.

SUITER, Wilbur Carleton, M.E., '13. 759 Locust St., York, Pa.

SULLIVAN, Alexander Camman, M.E., '09. 2d Lieut., Coast Artillery Corp., Manila Bay, P. I.

SULLIVAN, Leo James, M.E., '13. Cadet Engr. (1) and (3) 184 N. Union St., Rochester, N. Y. (2) Rochester Ry. & Lt. Co., Rochester, N. Y.

SUMMER, Wilhelm Carl, M.E., '06. Lumber Business, Pomaria, S. C.

SUMNER, Grover Cleveland, '07. Lemon Grove, San Diego, Cal.

SUN, Kia Loh Carlos, M.E., '09. 517 N. Soochon Rd., Shanghai, China.

SUREN, Natham Hazop, '79. Marash, Asia Minor.

SUTHERLAND, Edward Ross, M.E., '09. Care Va. Ry. & Pr. Co., Norfolk, Va.

SUTCLIFFE, Harold Taylor, M.E., '16. Operating Dept. (1) 31 Forbus St., Poughkeepsie, N. Y. (2) and (3) Pacific Gas & Elec. Co., East Auburn, Cal. A. I. E. E.

SUTLIFF, Edward Milton, M.E., '93. (1) 885 W. End Ave., New York City. (2) Vice-Pres. Am. Trading Co. (3) 25 Broad St., New York City.

SUTTON, Frank Edgar, M.E., '05. Naples, N. Y.

SUTTON, H. Craig, M.E., '07. Asst. to Elec. Engr., W. G. I. Co. (2) and (3) 1401 Arch St., Philadelphia, Pa. (1) Haverford, Pa. Box 1902, Philadelphia, Pa. A. I. E. E., N. E. L. A.

SUTTON, Seymour H., '11. (2) Gould Mfg. Co., Chicago, Ill. (1) and (3) 5904 Normal Blvd., Chicago, Ill.

SUTTON, William John, '78. Victoria, B. C., Canada.

SWALM, John Moffatt, M.E., '12. Mgr. Auto Dept., Swalm Hardware Co. (2) 21 N. Centre St., Pottsville, Pa. (1) and (3) 1327 Howard Ave., Pottsville, Pa.

SWALM, Robert Allen, M.E., '14. 1313 Mahantongo St., Pottsville, Pa.

SWAN, Lawrence, '11. Royal Ridge Farm, Front Royal, Va.

SWAN, John Joseph, M.E., '97. (2) and (3) 1482 Broadway, New York City. (1) 1208 Watchung Ave., Plainfield, N. J. A. S. M. E.

SWAN, Wm. G., M.E., '99. Chief Engr., McArthur Bros. Co., 120 Broadway, New York City. 21 Edgewood Ave., Nutley, N. J.

SWAN, William Lincoln, jr., '04. Box 227, Oyster Bay, N. Y.

SWEET, Henry Wells, '04. Phoenix, N. Y.

SWEET, Horace Bummer, '94. The Olbiston, Utica, N. Y.

SWEET, Richard Leigh, '06. (2) and (3) 413 Produce Exchange, New York City. (1) Yonkers, N. Y.

SWEET, Vaughn Charles, '83. Address unknown.

SWEET, William Charles, '05. Cascade, Mont.

SWIFT, Frank Houston, M.M.E., '11. Creswell Ore., R. F. D. 1.

SWIFT, Lewis Burril, M.E., '12. Sales Engineer. (2) Taylor Instrument Companies, Rochester, N. Y. (1) and (3) 114 Warwick Ave., Rochester, N. Y.

SWIFT, Pemberton Reno, M.E., '07. 42 South St., Ridgway, Pa.

SWIGERT, William Edwin, M.E., '07. Western Elec., New York City. 36 Park Ave., Passaic Pk., N. J.

SWINNERTON, Arthur Adin, '09. 49 N. Main St., Rutland, Vt.

SWINTON, David Russell, M.E., '11. Engr. for Perfection Spring Co. (1) and (3) 5912 Normal Blvd., Chicago, Ill. (2) Care Perfection Spring Co., Cleveland, O. A. S. M. E., S. A. E.

SWITZER, Fred'k George, M.M.E., '14. (2) Instructor of Hydraulics, Sibley College, Cornell Univ., Ithaca, N. Y. (1) and (3) 202 Stewart Ave., Ithaca, N. Y. Assoc. A. I. E. E., Sigma Xi.

SWITZER, John Albert, M.E., '96. Univ. of Tenn., Knoxville, Tenn.

SWYER, Frederick Lincoln, '03. Care Northwestern Malleable Iron Co. Milwaukee, Wis.

SYMES, Wilbur Henry, '09. Address unknown.

SYMONDS, George Parker, '93. 95 Liberty St., New York, N. Y.

SYMONDS, Reymond William, M.E., '13. Sprague Elec. Works, Bloomfield, N. J.

SZE, Soa-chiang Thomas, M.E., '05. Kailan Mining Administration. Tientsin, China.

TABER, Silas, M.E., '05. Supt. Auburn Converting Co. (2) and (3) 185 Clark St., Auburn, N. Y. (1) 35½ Elizabeth St., Auburn, N. Y. N. Y. State Private Water Wks. Assn., A. I. E. E.

TABOR, Edmund Rhett, jr., '08. R. F. D. 2, Mountain Creek, Ala.

TAG, Frederick Casimir, '01. Belmar, N. J.

TAKATSUJI, YOSKIMARO, M.E., '98. 18 Gocho Me Fujimicho, Kojimachi-Ku, Tokio, Japan.
TALBOTT, H. WORTHINGTON, M.E., '99. Rockville, Md.
TALBOYS, HENRY HANSCOMB, '04. 424 21 Ave., East Duluth, Minn.
TALCOTT, JOHN CHAMBERLAIN, M.E., '09. 253 W Ferry St., Buffalo, N. Y.
TALL, GEORGE WASHINGTON, JR., M.E., '13. United Gas Imp. Co., Philadelphia, Pa.
TALLNAN, FRANK GIFFORD, '80. Care E. I. Du Pont Co., Wilmington, Del.
TALLMAN, FRANK GIFFORD, JR., M.E., '17. 1102 Broome St., Wilmington, Del.
TALMAN, LYMAN ALFRED, M.E., '12. Student for Ministry. Spring Valley, New York.
TALLMAN, RALPH, '96. 54 Elizabeth St., Ogdensburg, N. Y.
TAPPEN, ALEXANDER BONNELL, '01. Pres. Cooling Tower Co., Inc., (2) and (3) 50 Broadway St., New York, N. Y. (1) Ossining, N. Y.
TAPPAN, FRANK GIRARD, M.E., '07. Instr. in Elec. Eng. (2) Cornell Univ., Ithaca, N. Y. (1) and (3) Forest Home, Ithaca, N. Y. A.I. E. E.
TAPPEY, HOWARD POMFRETT, M.E., '07. 108 Chamberlin Ave., Liberty, N. Y.
TARR, CHARLES BACON, '97. Geiger, Ala.
TARBOX, EDWARD BASSETT, '79. Address not known.
TASSIE, ROBERT WILSON, M.E., '09. (2) Hav. Elec. Ry. Co., Havana, Cuba. (3) Box 570, Havana, Cuba.
TATUM, LEWIS L., M.E., '97. Asst. Chief Engr., Cutler Hammer Mfg. Co. (2) Cutler Hammer Mfg. Co., Milwaukee, Wis. (1) and (3) 621 Downer Ave., Milwaukee, Wis. A. I. E. E., Engr. Soc. of Milwaukee, Ill. Engr. Soc., Mil. Elec. League.
TATE, ARTHUR CHILD, '98. Draughtsman, Highland Rd., Stamford, Conn.
TATE, ROBERT L'HOMMEDIEU, '11. 1097 Elmwood Ave., Buffalo, N. Y.
TAUSSIG, JOHN HAWLEY, M.E., '97. United Gas Impl. Co., Broad and Arch Sts., Philadelphia, Pa.
TAVEIRA, HORACIO ALFREDO, '03. Agua Cate 66, Havana, Cuba.
TAVENNER, FRANK LUCIUS, M.E., '05. Address not known.
TAYLOR, ALEXANDER CLINTON, '95. 231 W. Euclid Ave., Springfield, O.
TAYLOR, CHARLES FINE, M.E., '95. Treas. and Gen. Mgr., Lummis & Co. Peanut Factory, Suffolk, Va.
TAYLOR, CHARLES KEEN, '06. Mermaid Lane and Navahoe St., St. Martins, Philadelphia, Pa.
TAYLOR, E. A., M.E., '14. Engrg. Dept. Four Wheel Drive Auto Co., Clintonville, Wis.
TAYLOR, FRED KALBFLEISCH, '09. 95 Ames St., Rochester, N. Y.
TAYLOR, GORDON MCDOUGALL, '05. (1) 301 Quincy Ave., Scranton, Pa. (3) Box 325, Scranton, Pa.
TAYLOR, JOHN MYERS, '88. Builder. (2) Albany, N. Y. (1) 362 Clinton Ave., Albany, N. Y.
TAYLOR, LYNDON BIGLOW, M.E., '97. Address not known.
TAYLOR, HENRY MENDINHALL, JR., M.E., '15. Care Remington Machine Co., Wilmington, Del.
TAYLOR, JOHN MEYERS, M.E., '88. 362 Clinton Ave., Albany, N. Y.
TAYLOR, J. PARKER, M.E., '04. Engr. Traffic Engrs. Office. (2) 15 Dey St., New York City. (1) and (3) Tenafly, N. J.
TAYLOR, PERCY JAMES, '11. Gordon & Taylor Cons. Co. 330 Century Bldg., Denver, Col.
TAYLOR, RALPH CORBIN, M.E., '17. 112 Roland Ave., Roland Park, Baltimore, Md. Tau Beta Pi.
TAYLOR, RICHARD SALMON, M.E., '12. Eng. Asst., N. Y. Telephone Co. (2) and (3) 15 Dey St., New York City. (1) 1195 Union St., Brooklyn, N. Y. A. I. E. E., T. Soc. N. Y.
TAYLOR, THOMAS BASSETT, '01. 5 E. 42 St., New York, N. Y.
TAYLOR, THOMAS ROGERS, M.E., '12. State St., Vineland, N. J.
TAYLOR, WALLER, M.E., '95. (1) 938 Lake St., Los Angeles, Cal. Vice-Pres. Llewellyn Iron Wks., (2) and (3) Los Angeles, Cal.
TAYLOR, WILLIAM ARNOLD, M.E., '15. 55 Rutland Rd., Brooklyn, N. Y.
TAYLOR, WILLIAM ARTHUR, M.E., '94. Rancher. R. F. D. 1, Box 60, Glenn, Glenn Co., Cal.
TAYLOR, WILLIAM DUNCAN, M.E., '13. 5742 Center Ave., Pittsburgh, Pa.
TAYLOR, WILLIAM GORTON, M.E., '07. Electrical Engineer. (2) Power & Mining Eng. Dept., G. E. Co., Schenectady, N. Y. (1) 26 Crescent Place, Middletown, N. Y. (3) 615 Union St., Schenectady, N. Y. A. I. E. E.
TAYLOR, WILLARD HERBERT, M.E., '13. Standard Oil Co., Yokahoma, Japan.
TEAGLE, FRANK HENRY, M.E., '02. (2) and (3) 1125 Oregon Ave., Cleveland, Ohio. (1) 8418 Euclid Ave., Cleveland, O. S. H. E.
TEAL, ARTHUR RAYMOND, M.E., '00. 180 Burr St., Rochester, N. Y.
TEEPLE, GEORGE LEONARD, M.E., '89. Writer and Surveyor. 302 S. Prince St., Whitewater, Wis.
TEHLE, CHARLES JOHN, M.E., '14. (1) 3148 W. 12th St., Chicago, Ill. (2) Kerr Turbine Co., Wellsville, N. Y. (3) Box 269, Wellsville, N.Y.
TELLER, S. JAY, M.E., '06. Patent Attorney. (1) 35 S. Oxford St., Brooklyn, N. Y. (2) and (3) For Niles Bement Pond Co., 111 Broadway, New York City.
TEMPLE, HERBERT ASHER, M.E., '06. 230 Portage Ave., Three Rivers, Mich.
TEN BROECK, FLOYD GUNN, M.E., '95. Cons. Engr. (1) 1421 Glenwood Rd., Brooklyn, N. Y. (2) and (3) 200 5th Ave., New York City.
TENNANT, FREDERICK ADAMS, M.E., '93. 613 Old South Bldg., Boston, Mass.
TER KUILE, CURTIS VERBURG, M.E., '14. Montvale, N. J.
TERRY, ALVAH LAMAR, JR., M.E., '08. 504 W. Ormsby St., Louisville, Ky.
TERRY, JAMES PUGH, '11. Farmer. Sound Ave., Riverhead, L. I., N. Y.
TERRIBERRY, GEORGE GIBSON, M.E., '15. Care Niles Tool Works, Hamilton, O.
TERWILLIGER, HARRY LESTER, M.E., '97. Dist. Mgr. for Ingersoll Rand Co. (1) 575 Emfarcadero Rd., Palo Alto, Cal. (2) Rialto Bldg., San Francisco, Cal. A. S. M. E.
TEWKSBURY, BAIRD RUSSELL, '10. 2126 E. 21 St., Cleveland, O.
THATCHER, FREDERICK HOYT, M.E., '96. 407 Oliver Bldg., Pittsburg, Pa.
THAYER, CHAS. S., M.E., '13. Const. Elec. Supt. (1) 550 Riverside Drive, N. Y. (2) and (3) Aluminum Co. of America, Massena, N. Y.
THAYER, GUY HAROLD, M.E., '90. Ranier, Ore.
THAYER, GEORGE LANGSTAFF, M.E., '92. Daisy, Wash.
THAYER, HORACE HOLDEN, JR., M.E., '00. Eng. Naval Architect and Marine Surveyor. (2) and (3) Drexel Bldg., Philadelphia, Pa. S. N. A. and M. E., A. S. M. E., Sigma Xi, Phila. Maritime Exchange.
THAYER, SAMUEL GEORGE, '03. 11 Strathallan Park, Rochester, N. Y.
THOMAN, JOHN PHILIP, '76. Lansing, Mich.
THOMAS, BEVERLY, JR., M.E., '15. Hague-on-Lake George, N. Y. A. I. E. E.
THOMAS, CARL CLAPP, M.E., '95. (1) 114 Roland Ave., Roland Park, Md. (2) and (3) John Hopkins Univ., Baltimore, Md.
THOMAS, CASSIUS AUXASSA, M.E., '00. Gen. Elec. Co., Omaha, Neb.
THOMAS, CLAUDE BERTRAM, M.E., '11. Boxtoe Mfg. (1) 253 Prospect St., Brockton, Mass. (2) 97 Belmont St., Brockton, Mass.
THOMAS, CHARLES E., M.E., '13. Instructor in Sibley College. (1) 219 Bryant Ave., Ithaca, N. Y. (2) and (3) Sibley College, Ithaca, N. Y. Tau Beta Pi, Sigma Xi.
THOMAS, DAVID RADER, M.E., '01. Treas. and Mgr. Jervis Light & Power Co., Port Jervis, N. Y.
THOMAS, FELIX, M.E., '10. Cornell Club, New York City.
THOMAS, GORDON, '01. Address not known.
THOMAS, JAMES MANTELLE, JR., M.E., '94. Insp. Norfolk & Western R. R. Box 272, Roanoke, Va.
THOMAS, JOHN RADER, '07. Catasauqua, Club, Catasauqua, Pa.
THOMAS, JOHN THOMAS, M.E., '05. 607 S. Main St., Scranton, Pa.
THOMAS, JOSEPH EDGE, M.E., '08. (1) 200 Franklin Ave., Wilkinsburg, Pa. (2) and (3) Darlington, Md.
THOMAS, ROYAL DAVID, M.E., '06. Elec. Engr. Oakmont, Pa.
THOMAS, WILLIAM HENRY, M.E., '04. (1) 144 East H Blvd., Elyria, O. (2) and (3) National Tube Co., Lorain, O.
THOMPSON, BYRON L., M.E., '03. Asst. Mgr. Solvay Process Co. (2) and (3) Solvay Process Co., Syracuse, N. Y. (1) 610 Allen St., Syracuse, N. Y. A. S. M. E.
THOMPSON, CHARLES LEWIS, M.E., '06. Alexandria Bay, N. Y.
THOMPSON, EDWARD ROUSE, M.E., '10. Care H. N. Kingshipway, St. Louis, Mo.
THOMPSON, ELMER IVES, '09. (1) 243 Jefferson Ave., Brooklyn, N. Y. (2) and (3) 454 E. 25 St., Brooklyn, N. Y.
THOMPSON, ERWIN WILLIAM, B.M.E., '81. American Embassy, Holland.
THOMPSON, EUSTIS HENRY, M.E., '05. Consulting Engr. and Power House Expert. (1) 3137 N. Calvert St., Baltimore, Md. (2) and (3) 1122 Munsey Bldg., Baltimore, Md.
THOMPSON, HARRISON COFFIN, '06. Daytona, Fla.
THOMPSON, HAROLD JULIAN, M.E., '14. 148 Newton St., Eau Claire, Wis.
THOMPSON, HARRY ELLIOTT, M.E., '02. (1) 119 Bennett St., Three Rivers, Mich. (2) Water Service Engr., Sheffield Car Co.
THOMPSON, JEROME TYLER, '11. 458 W. Water St., Elmira, N. Y.
THOMPSON, JOHN REDBURN, '03. Uniontown, Pa.
THOMPSON, MILTON ELLSWORTH, M.E., '90. New Hyde House, Ridgway Pa.
THOMPSON, MILTON WESLEY, M.E., '95. Pres. Thompson & Moseley, Inc. Greensboro, N. Car.
THOMPSON, OVERTON, '09. Nashville, Tenn.
THOMPSON, PAUL WHEELER, '10. Tech. Engr. (1) 556 Hamilton Ave., Detroit, Mich. (2) and (3) 18 Washington Ave., Detroit, Mich. Am. S. M. E., Detroit Engr. Soc.
THOMPSON, RAY CLAYTON, M.E., '09. (1) 72 Regent St., Welland, Ont., Can. (2) and (3) Union Carbide Co., Welland, Ont., Canada.
THOMPSON, THOMAS PERRIN, M.E., '98. Seaboard Bank Bldg., Norfolk, Va.
THOMPSON, ULDRIC, JR., M.E., '14. (1) Alpha Delta Phi Club, New York City. (2) Chief Engr., Shell Plant, care J. A. Gillespie Co., Parlin, N. J. (3) 136 W. 44th St., New York City. A. S. M. E., Sigma Xi, Eng. Soc. Penn.
THOMSON, IRA REED, '07. Holland Patent, N. Y.
THOMSON, JOHN EDGAR, M.E., '11. 253 Broadway, New York, N. Y.
THOMSON, WILLIAM HARGARDINE, M.E., '98. Des Moines Elec. Co., Des Moines, Ia.
THORNE, HAROLD WOOSTER, M.E., '16. (1) 25 Naco Ave., Bisbee, Ariz. (2) and (3) Bisbee-Naco Water Co., Bisbee, Ariz.
THORNE, WILLIAM JAMES, M.E., '11. (2) and (3) 410 Vinney Bldg., Syracuse, N. Y. (1) 121 Green St., Syracuse, N. Y.
THORP, GEORGE BOULTON, A.B., '14, M.E., '16. 326 Maple Ave., Edgewood Pk., Pittsburgh, Pa. Tau Beta Pi.
THRALL, WILLIAM AUSTIN, JR., '05. 416 Elder Lane, Winnetka, Ill.
THREEFOOT, LOUIS MARKS, M.E., '11. Meridian, Miss.
THROCKMORTON, GEORGE KENNETH, '09. 3830 W. Adams St., Chicago, Ill.
THROCKMORTON, JOHN BAYARD, '08. 218 Broad St., Red Bank, N. J.
THROOP, FRANCIS WAYLAND, M.E., '92. R. F. D. 1, St. Catherines, Ont., Can.
THURBER, HOWARD FORD, M.E., '90. Vice-Pres. New York Telephone Co. 15 Dey St., New York, N. Y.
THURSTONE, LOUIS LEON, M.E., '12. Instructor in Psychology, Carnegie Institute of Technology. Pittsburgh, Pa.
TIBYPICA, JOSE PIRATININGA, B.M.E., '79. 79 Rua Barco de Tatulz 8, Sao Paulo, Brazil, S. A.
TICHENOR, ELMORE DUANE, '08. Detroit, Mich.
TICKNOR, WILLIAM HARRISON, '07. Address not known.
TIDD, GAGE WASHBURN, M.E., '13. 412 Euclid Ave., Elmira, N. Y.
TIEDEMAN, LUTHER, '07. 30 Broad St., Charleston, S. C.
TIERS, CLARENCE FORESMAN, '00. 810 Farmers Bank Bldg., Pittsburg, Pa.
TIFFANY, EDWARD LEWIS, M.E., '08. Elec. Engr. (2) 39 Boylston St., Boston, Mass. (1) and (3) 68 High Rock St., Lynn, Mass.
TIFFANY, JOSEPH BURR, '78. 234 Palisade Ave., Yonkers, N. Y.
TIFFT, ROBERT HULL, M.E., '09. 196 Linwood Ave., Buffalo, N. Y.
TILLEY, NORMAN NEVILL, M.E., '15. 98 Baxter St., Buffalo, N. Y.
TILSON, HOWARD, M.E., '13. Mgr. Ill. Div. Workmen's Comp. Serv. Bureau. (2) and (3) 753 Insurance Exchange, Chicago, Ill. (1) 45A 3d St., Brooklyn, N. Y. A. S. M. E., National Safety Councils, Casualty Actuarial and Statistical Society.
TILDEN, ALFRED MOSHER, '11. Winter Haven, Fla.
TILDEN, GEO. ALFRED, '09. 31 Wendell Ave., Pittsfield, Mass.
TILESTON, ARTHUR, '08. St. Cloud, Minn.
TILLOTSON, WILLIAM OGDEN, JR., '96. Greenville, Pa.
TILTON, ROLIN LARRABEE, '11. Fort De Russy, Hawaii.
TIMMERMAN, ARTHUR HENRY, M.M.E., '93. 6400 Plymouth Ave., St. Louis, Mo.
TIMMERMAN, ARTHUR PEARSON, M.E., '17. 5712 Cabanne Ave., St. Louis, Mo.
TIMMERMAN, CHARLES EDWARD, M.E., '92. DeWitt Clinton H. S., New York, N. Y.
TIMMERMAN, LYNN BYRON, M.E., '14. (1) 2320 Murray Hill Rd., Cleveland, O. (2) and (3) Cutler Hammer Co. of Milwaukee. 1023 Schofield Bldg., Cleveland, O.
TIMMERMAN, ROY, M.E., '06. Dist Supt. Utah Power & Light Co., Bingham Canyon, Utah. A. I. E. E., N. E. L. A., Univ. Club at Salt Lake City.
TINGLEY, EDWARD HARRINGTON, M.E., '09. Head of Vocational Dept. (2) and (3) Buffalo State Normal School, Buffalo, N. Y. (1) 356 Auburn Ave., Buffalo, N. Y. Nat. Soc. for the Promotion of Industrial Education.
TINKER, JOSEPH BEARD, M.E., '99. Rock Stream, N. Y.
TINNEY, HENRY CYREANUS, '96. Care Tinney, Keiger Co., Indianapolis, Ind.
TINNIN, DAVE FOSTER, '08. 513 S. Main St., Paris, Texas.
TITCHENER, PAUL F., M.E., '13. Secretary and Plant Supt., E. H. Titchener & Co. (1) (2) and (3) 15 Oak St., Binghamton, N. Y.
TITCHENER, WALTER EDMUND, M.E., '17. 94 Clinton St., Cortland, N. Y.
TITUS, FRED ALLYN, '91. Prop. of Star Seeder Co., Shortsville, N. Y.
TITUS, ROLLA WILLIAMS, '13. 708 E. 5th St., Galena, Kans.

TITUS, SILAS JOSEPH, '06. 428 Midland Ave., Syracuse, N. Y.
TITUS, WETMORE HOLLOWAY, M.E., '05. Goulds Mfg. Co., Seneca Falls N. Y.
TOBEY, HARRY WILLARD, M.E., '97. Electrical Engr. (2) G. E. Co Pittsfield, Mass. (1) and (3) 24 Taylor St., Pittsfield, Mass.
TOBIN, ROBERT PIERCE, '96. (1) 54 Roosevelt Ave., E. Orange, N. J. (2) and (3) Vacuum Oil Co., 61 Broadway, New York City.
TODD, THOMAS WARING, '07. 1123 Muncey Bldg., Baltimore, Md.
TODD, JOHN WILLIAM, M.E., '06. (1) 335 Rovedale St., Wilkinsburg, Pa. (2) and (3) 2030 Oliver Bldg., Pittsburg, Pa.
TODD, OTIS HOWARD, M.E., '08. Griffins Corners, N. Y.
TODD, W. T., JR., M.E., '16. 327 Water St., Pittsburgh, Pa.
TOLMAN, EDGAR BRONSON, JR., '15. Taking shop course with Ford Motor Co. (3) 2977 West Grand Blvd., Detroit, Mich. (1) 5554 Woodlawn Ave., Chicago, Ill. S. A. E. and Detroit Section, Detroit Alumni Club, Sec. Auto. Engrs.
TOMLINES, THOMAS FREDERICK, '17. Illingworth, 315 Keyes Ave., Watertown, N. Y.
TOMKINS, WALTER MCEWAN, M.E., '15. (1) 704 9 Ave., Seattle, Wash. (2) and (3) Care Ingersoll Rand Co., Easton, Pa.
TOMLINSON, DANIEL WEBB, JR., '94. 3 Vine St., Batavia, N. Y.
TOMPKINS, ERNEST, M.E., '98. Expert in Stammering. (1) 1994 N. Los Nobles Ave., Pasadena, Cal. Sigma Xi.
TOMPKINS, GEORGE RICKS, M.E., '10. Wilberforce Univ., Wilberforce, O.
TOMPKINS, HAROLD DOREMUS, M.E., '10. 533 Communipaw Ave., Jersey City, N. J.
TOMPKINS, SIDNEY, '01. Address not known.
TOMPKINS, SAMUEL COLES, '97. Address not known.
TOMPKINS, WALTER HALL, '91. 600 Prospect Ave., Milwaukee, Wis.
TOMS, KEEFER SAMUEL, '03. 7 E. South St., Frederick, Md.
TONE, FRANK J., M.E., '91. Works Mgr., Carborundum Co. (2) and (3) Carborundum Co., Niagara Falls, N. Y. (1) 328 Buffalo Ave., Niagara Falls, N. Y. Amer. Elec. Chem., American Ceramic, Amer. Chem. Soc. Chem. Ind., Amer. Inst. Metals.
TONG, WILLIAM SU-LEVA, M.E., '13. 16 Museum Rd., Shanghai, China.
TONKIN, LORING LOMBARD, M.E., '12. Hope Natural Gas Co., Clarksburg, W. Va.
TORRANCE, CHARLES E., M.E., '09, M.M.E., '12. Chief Engr. and Facty. Mgr., Machine Shop Div. (2) E. F. Perkins & Sons, Inc., Holyoke, Mass. (1) 81 Harrison Ave., Northampton, Mass. (3) P. O. Box 72, Holyoke, Mass. A. S. M. E., Sigma Xi.
TOPP, ROGER, '07. Stanford Univ., Palo Alto, Cal.
TORRANCE, FREDERICK CALKINS, M.E., '11. Care Lackawanna Steel Co. 132 Lancaster Ave., Buffalo, N. Y.
TORIAN, THOMAS RICHARD, M.E., '03. Midway Mills Co., Nelson Co., Va.
TORNEY, HENRY WALTER, '04. Address not known.
TOURISON, ASHTON STEPHEN, JR., M.E., '01, M.M.E., '02. 7014 Boyer St., Germantown, Philadelphia, Pa.
TOURTELLOT, JERRY WILLIAMS, M.E., '92. Ithaca, N. Y.
TOUSSAINT, ARTHUR FREDERICK CLEVELAND, M.E., '14. Eng. Dept., N. Y. Central R. R. Co. (1) and (3) 2966 Briggs Ave., New York, N. Y. (2) Room 4624 G. C. Terminal, New York City.
TOWER, CLARENCE LOTHROP, '11. A. F. Carver & Co., Newtonville, Mass.
TOWERS, ALAN CAMPBELL, M.E., '11. Calle Yaguaren 1938, Montevideo, Uruguay.
TOWLE, THOMAS STEVENS, M.E., '14. Stanton, Mich.
TOWNLEY, JOHN CAMPBELL, '07. 108 Cascadilla Park, Ithaca, N. Y.
TOWNSEND, ARTHUR CRITCHLOW, '95. 932 Wilson, Chicago, Ill.
TOWNSEND, CLARENCE E., M.E., '07. Instr. in Senior Machine Design. (2) Cornell University, Ithaca, N. Y. (1) and (3) 413 Utica St., Ithaca, N. Y.
TOWNSEND, FREDERICK B., '08. Patent Lawyer. (2) and (3) 149 Broadway, New York City. (1) 238 W. 101st St., New York City.
TOWNSEND, GEORGE RAPPLEYE, '92. Sales Mgr. Inter. Time Recording Co. (3) 343 Plymouth Bldg., Minneapolis, Minn. (1) 2420 Russell Ave., South Minneapolis, Minn.
TOWNSEND, STEPHEN HEWLETT, M.E., '03. Glen Head, N. Y.
TOYOMURA, CHUSHIRO, M.E., '13. 370 Yunoki-mura, Nagasaki-ken, Japan.
TOZER, JOB ROBERT, '15. 17 Park Ave., Waverly, N. Y.
TRACY, HAYDEN HOMER, M.E.E., '93. Pres. Tracy Engrg Co., 461 Market St., San Francisco, Cal.
TRACY, LYNDON SANFORD, M.E., '98. (1) 12 Brattle Rd., Syracuse, N. Y. (2) and (3) Care Solvay Process Co., Syracuse, N. Y.
TRACY, REGINALD PIERCE, '06. 40 Ranthorne Rd., 10 Roxbury, Mass.
TRACY, MORRIS, M.E., '09. Penn Yan, N. Y.
TRAEGER, PAUL, JR., M.E., '13. 4 E. 120 St., New York, N. Y.
TRAINER, EDWARD, '13. 758 S. 10 St., Philadelphia, Pa.
TRAUTSCHOLD, REGINALD, M.E., '02. Consulting Engr., Engrg. Economist, Statistician. 39 Charles St., New York City. A. S. M. E.
TRAVELL, IRA WINTHROP, '96. Prin. High School, Plainfield, N. J.
TRAVERS, HENRY A., M.E., '06. Estimating Engr., Switchboard & Power Plant Design, Westinghouse Mfg. Co. (2) and (3) E. Pittsburgh, Pa. (1) R. F. D. 5, Wilkinsburg, Pa. A. I. E. E.
TRAVERS, WILLIAM JOSEPH, '09. 420 Parkside Ave., Buffalo, N. Y.
TREAT, CHARLES HENRY, M.E., '04. (2) and (3) American Blower Co., (1) 98 Marquette Ave., Detroit, Mich.
TREAT, SIDNEY WELLINGTON, M.E., '07. (1) 137 Broadway, Bayonne, N. J. (2) and (3) Babcock Willcox Co., Bayonne, N. J.
TREE, RUSSELL THOMAS, M.E., '17. 113 DeWitt Place, Ithaca, N. Y.
TREE, RUSSELL THOMAS, '14. Eastman Kodak Co., Rochester, N. Y.
TREENE, WILLIAM H., M.E., '10. Designing Engr. (2) A. C. Engrg. Dept., G. E. Co. (2) Schenectady, N. Y. (1) 465 Summer Ave., Newark, N. J. (3) 41 N. Wendell Ave., Schenectady, N. Y.
TREFTS, JOHN CHILION, M.E., '02. 60 Perry St., Buffalo, N. Y.
TREGANZA, HOWARD JOSEPH, M.E., '98. Supt. The Ansonia Clock Co. (1) 503 10 St., Brooklyn, N. Y. (2) 7th Ave., betw. 12th and 13th Sts., Brooklyn, N. Y.
TREGO, ALBERT CARROLL, M.E., '13. 18 E. 41 St., Workmen's Compensation Service Bureau, New York, N. Y.
TREMAN, ROBERT HENRY, B.M.E., '78. Ithaca, N. Y.
TREVOR, KARL ROBERT, '15. The Circle, Ithaca, N. Y.
TRICK, WILLIS SAMUEL, '85. Teacher. South Byron, N. Y.
TRIMBEY, EDWARD J., M.E., '05. Inspector Economics Internatl. Paper Co. (2) International Paper Co., Glens Falls, N. Y. (1) and (3) 38 Notre Dame St., Glens Falls, N. Y. Technical Assn. of the Pulp & Paper Industry.
TRIMBLE, FRANCIS WILSON, M.E., '88. 32 W. 40 St., New York, N. Y.
TRIPP, FRANK SILSBY, '79. Address not known.
TRORLICHT, OSCAR ALBERT, M.E., '08. Care L. Fabacher, New Orleans, La.
TROTT, JOHN WINSLOW, '07. 702 Buffalo St., Niagara Falls, N. Y.
TROTT, ROLLAND STINSON, M.E., '04. (1) 339 Hurlburt Ave., Detroit, Mich. (2) and (3) 723 Chamber of Commerce, Detroit, Mich.
TRUBE, HERBERT L., M.E., '08. Vice-Pres. Ford Trube Co. (Advertising Mechanisms). (2) 1700 Tower Bldg., Chicago, Ill. (1) 1725 Wilson Ave., Chicago, Ill.. Chairman, Shepherds Journal Pub. Co. Trustee Int'l Food Prod. Co.
TRUESDELL, EDWIN SUMMERS, JR., M.E., '14. 100 Murray St., Binghamton, N. Y.
TRUMBULL, ALONZO GEORGE, M.E., '99. Franklin St., Englewood, N. J.
TRUMP, CHARLES CROASDALE, M.E., '11. (1) 1912 W. Genesee St., Syracuse, N. Y. (2) and (3) 401 S. A. & N. Bldg., Syracuse, N. Y.
TRYON, CLARENCE A., M.E., '01. Eng. Acheson Graphite Co. (2) Niagara Falls, N. Y. (1) La Salle, N. Y. (3) P. O. Box 616, Niagara Falls. A. S. M. E.
TSAI, KUO TSAO, M.E., '09. 5 Race Course Rd., Tientsin, China.
TSANG, KWONG CHI, M.E., '17. Cosmopolitan, Ithaca, N. Y.
TSANG, YIN SUN, '11. Address not known.
TSCHABOLD, FRANK FREDERICK, '05. 412 Jefferson St., Niagara Falls, N. Y.
TSCHENTSCHER, RUDOLPH, M.E., '98. Ill. Steel Co., S. Chicago, Ill.
TSCHIRKY, LEOPOLD, M.E., '12. Bethlehem Steel Co. (2) S. Bethlehem, Pa. (1) and (3) 34 N. 8th Ave., Bethlehem, Pa.
TSEN, MONG KANG, M.E., '14. Chungking, P. O. Chungking, China.
TSUCHIYA, SHUSEI, M.E., '13. 82 Takehaya Cho, Korshikawakee, Tokio, Japan.
TUDELS, GABRIEL, M.E., '06. Apartado 973, Lima, Peru.
TUERK, FRED S., M.E., '07. Sec. The Thompson-Carroll Co. (Advertising) (2) and (3) 511 Leader News Bldg., Cleveland, O. (1) 1954 E. 73d St., Cleveland, O.
TUCKER, EARL F., M.E., '12. General Main and Service Foreman. (2) United Gas Improvement Co., 1615 N. 9th St., Philadelphia, Pa. (1) and (3) 5820 Delancey Place, Philadelphia, Pa. Nat. Comm. Gas Assn.
TUMBRIDGE, JOHN WILLIAM, '96. Mgr. Hotel St. George, Brooklyn, N. Y.
TUMBRIDGE, STANLEY SPARTAN, M.E., '01. Captain N. G., N. Y., Mgr. Hotel St. George. Hotel St. George, Brooklyn Heights, Brooklyn, N. Y.
TURLEY, CHARLES LESLIE, '14. 43 E. 2 St., Portsmouth, Ohio.
TURNBULL, JOHN GOURLAY, '11. 27 Cedar St., New York City.
TURNBULL, WALLACE RUPERT, M.E., '93. Rothesay, New Brunswick, Can.
TURNER, CHARLES FRANCIS, '91. Hudson, O.
TURNER, CLAUDE L., M.E., '13. Elec. Eng. (1) Clayton, N. J. (2) Marine Dept. G. E. Co., Schenectady, N. Y. (3) 216 Union St., Schenectady, N. Y. A. I. E. E.
TURNER, EDWARD THOMAS, M.E., '10. 228 Central Ave., Dayton, O.
TURNER, ERNEST ABBOTT, M.E., '01. Plattsburg, N. Y.
TURNER, GEORGE EDWIN, M.E., '93. Pres. and Gen. Mgr. Turner Fricke Mfg. Co., Farmer Bank Bldg., Pittsburg, Pa.
TURNER, JOHN BOOTH, M.E., '95. Rev. Cutter Serv., Washington, D. C.
TURNER, JOHN LAWRENCE, M.E., '02. 15 Dey St., New York City.
TURNER, JOSEPH BENSON, M.E., '09. 122 Front St., New York, N. Y.
TURNER, RALPH COIT, M.E., '06. Salesman. Link Belt Co. 39 and Stewart Ave., Chicago, Ill.
TURNER, ROBERT PATTERSON, M.E., '09. (1) 5732 McPherson Ave., St. Louis, Mo. (2) and (3) 512 Lake Ave.
TURNER, ROBERT TIFFT, JR., M.E., '08. 5732 McPherson Ave., St. Louis, Mo.
TURNER, WILLIAM WOOD, '15. 1215 Elmwood St., Evanston, Ill.
TURPIN, MANLY CURRY, '05. Address not known.
TUTTLE, CHARLES LE ROY, '04. 3 Thayer St., Rochester, N. Y.
TUTTLE, D. S., '13. 205 West 89th St., New York City.
TUVIN, JULIUS HAROLD, M.E., '12. Sales Engr. (2) The Tuvin Co., Pittsburgh, Pa. (1) 300 N. Negley Ave., Pittsburgh, Pa.
TWELLMEYER, GEORGE BERNARD, '96. Yazoo City, Miss.
TYDEMAN, ARTHUR FREDERICK, M.E., '10. Pressed Steel Car Co., Pittsburg, Pa.
TYDEMAN, STEPHEN JAMES, M.E., '06. 463 Franklin St., Bloomfield, N. J.
TYDEMAN, WILLIAM ALFRED, M.E., '03. Paximosa Ave., Easton, Pa.
TYLER, FREDERICK HAROLD, M.E., '13. (1) 3246 Smart Ave., Kansas City, Mo. (2) and (3) Y. M. C. A., Dayton, O.
TYLER, JOHN J., '72. Address not known.
TYMESON, CHARLES PRINDLE, M.E., '16. 58 E. Main, Johnstown, N. Y.
TYSON, OSCAR S., '10. N. Y. Mgr. "Factory" Magazine. (2) 461 Fourth Ave., New York City. (1) 93 Bruce Ave., Yonkers, N. Y.
UHL, LEELAND MORGAN, M.E., '11. Investment Securities. (1) New Amsterdam Hotel, Cleveland, O. (2) and (3) Union National Bank Bldg., Cleveland, O.
UHL, VICTOR LEROY, M.E., '16. 15 Jennings St., Corning, N. Y.
UIHLEIN, HERMAN ALFRED, M.E., '08. Pres. Lavigue Gear Co., Racine, Wis.
ULBRICHT, T. CARLILE, M.E., '08, M.M.E., '12. Asst. to Pres. American Steel Co. of Cuba, Havana, Cuba. (1) Calle 11, 394 Entre 2 y 4 Vedado, Havana. (2) and (3) Empedrado 17, Havana, Cuba. A. S. M. E., Tau Beta Pi, Sigma Xi.
ULLMANN, RALPH W., M.E., '08. Mech. Engr., A. C. Dallas & Son. (2) 223 N. Jefferson St., Chicago, Ill. (1) and (3) 320 Chicago Ave., River Forest, Ill.
UMSTAD, WILFORD LE ROY, M.E., '09. 524 Frick Bldg., Pittsburg, Pa.
UNDERHILL, HARRY OSCAR, M.E., '14. Santa Rosalia, Chihuahua, Mex.
UNDERWOOD, HAROLD BARNES, M.E., '07. Care Racine Rubber Co., Racine, Wis.
UNGER, WILLIAM S., M.E., '16. With Carnegie Steel Co., Munhall, Pa. (2) and (3) Duquesne, Pa. (1) 5751 Aylesboro Ave., Pittsburgh, Pa.
UPDEGRAFF, DANIEL SMITH, M.E., '07. 1615 15th Ave., Seattle, Wash.
UPDIKE, C. M., '13. Princeton, N. J.
UPP, EDWIN LEE, '93. 642 11th Ave., Lorain, O.
UPP, JOHN WINTER, M.E., '89. 40 Wendall Ave., Schenectady, N. Y.
UPSON, MAXWELL MAYHEW, M.E., '99. (1) 83 Dwight Place, Englewood, N. J. (2) 140 Cedar St., New York, N. Y.
UPTON, DANIEL, M.E., '90. Principal, Buffalo, N. Y. State Normal School. (2) Buffalo, N. Y. (1) 110 14th St., Buffalo, N. Y.
UPTON, GEORGE BURR, M.E., '04, M.M.E., '05. Asst. Prof. Experimental Engrg. (2) Sibley College, Ithaca, N. Y. (1) and (3) 11 Central Ave., Ithaca, M. Y. Sigma Xi, A. S. T. M.
UPTON, WALLACE LINCOLN, M.E., '86. 3747 Raleigh St., Denver, Col.
URRUTIA, FERMIN, M.E., '08. Engineering Contractor. (2) and (3) Reconquista 46, Buenos Aires, Argentina. (1) Centro Nacional de Ingenieros, Buenos Aires.
URUIZA Y BEA, PEDRO, M.E., '99. Box 9, Matanzas, Cuba.
USHER, JOHN BLOOMFIELD, M.E., '09. Interlaken, N. Y.
UTZ, JOHN GILMORE, M.E., '02. (1) 554 Field Ave., Detroit, Mich. (2) ad (3) Perfection Spring Co., Cleveland, O.
VAIL, ALFRED CUSSON, M.E., '16. 23d & Howard Sts., Park Place, Chester, Pa. A. S. M. E.
VAIL, ATLEE GEROW, M.E., '09. 24 Westwood Ave., Providence, R. I.
VAIL, CARL WALDEMAR, '16. 141 Heights Rd., Ridgewood, N. J.
VAIL, HERMAN H., '11. Mgr. Asbestos Wood Mfg. Corp. (2) and (3) Asbestos Wood Mfg. Corp.., Poughkeepsie, N. Y. (1) 114 Academy St., Poughkeepsie, N. Y.
VAIL, STANLEY AARON, M.E., '10. 12210 Ingomar Ave., Cleveland, O.
VALADE, ERNEST AUGUSTUS, '17. C. U. A., Washington, D. C.
VALDIVIESO, ENRIQUE PEREZ, '97. Ponce, Porto Rico.
VALENTINE, WALTER SCOTT, M.E., '00. (1) 10 Bridge St., New York, N. Y. (2) and (3) 152 Bridge St., New York City.

VALENTINE, WARREN RUSSELL, M.E., '94. (1) Kittaning, Pa. (2) and (3) Lock Box 226, Ford City, Pa.
VALDES, J. M., M.E., '16. 100 Contreras, Matanzas, Cuba.
VALLADARES, ANTENOR, M.E., '06. 135 Gremios, Lima, Peru.
VAN BERGEN, KENNETH BROWN, '15. 880 Fairmount St., St. Paul, Minn.
VAN BIJLEVELT, JOANNES SAMUEL, M.E., '07. 4 Weimar St., The Hague, Holland.
VAN BLARCOM, CONANT, M.E., '08. (1) 2685 Euclid Heights Blvd. (2) and (3) 917 Illuminating Bldg., Cleveland, O. Care J. L. Stuart.
VAN BRUNT, J. H., JR., '13. 3601 Frederick Boulevard, St. Joseph, Miss.
VAN BUSKIRK, JOHN HAMLIN, '93. Grand Central Sta., New York, N. Y.
VAN BUREN, JAMES HENRY, '93. 93 Nassau St., New York City.
VAN CLEEF, HENRY HOWELL, '93. 3 Cannon St., Poughkeepsie, N. Y.
VANDERBEEK, HERBERT, '94. 718 W. Lake St., Canton, O.
VANDERHOEF, MARSHALL, M.E., '11. (1) 109 Joralemon St., Brooklyn, N. Y. (2) and (3) 30 E. 42 St., New York, N. Y.
VAN DERHOEF, HENRY ERNEST, M.E., '01. 481 Ernett Blvd., Rochester, N. Y.
VANDERLYN, DANIEL FITZGERALD, M.E., '14. (1) 51 Center St., Ellenville, N. Y. (2) and (3) 753 Insurance Exch. Bldg., Chicago, Ill.
VANDERPOEL, ANDREW CASE, '02. 18 Broadway, New York City.
VAN DERVOORT, WILLIAM HUMPHREY, M.E., '93. Moline Auto Co., E. Moline, Ill.
VANDERWAART, PETER THOMAS, M.E., '09. (1) 321 Main St., Norwich, Conn. (2) and (3) New Jersey Zinc Co., Palmerton, Pa.
VAN DEUSEN, CLINTON SHELDON, M.E., '94. Head of Dept. of Manual Training, Kent State Normal College, Kent, O. Eastern Arts Ass., Western Drawing and Manual Training Ass.
VAN DEVENTER, JOHN HERBERT, M.E., '03. 7 Philipse Pl., Yonkers, N. Y.
VAN DORN, THOMAS BURTON, '92. Van Dorn Iron Wks., Cleveland, O.
VAN EVEREN, HORACE, M.E., '91. Lawyer. (2) and (3) 53 State St., Boston, Mass. (1) 13 Kirkland Pl., Cambridge, Mass. Am. Bar Assn., Boston Bar Assn.
VAN FLEET, FRED, '76. W. 4th St., Williamsport, Pa.
VAN FLEET, HERMAN H., M.E., '07. Vice-Pres. Air Reduction Co., Inc. 50 Broad St., New York City.
VAN HOUTEN, WILLIAM ABRAM, M.E., '10. Lackawanna Steel Co., Buffalo, N. Y.
VAN KENNAN, HAROLD HOUSTON, M.E., '15. Mech. Engr. (1) Park Apartments, Punxsutawney, Pa. (2) Rochester & Pittsburgh Coal & Iron Co., Punxsutawney, Pa.
VAN LAW, CARLOS WHITNEY, M.E., '96. 55 Congress St., Boston, Mass.
VAN LAW, DURBIN, M.E., '13. Nevada Calif. Power Co., Bishop, Cal.
VAN LIERDE, JOSEPH, '09. Ingenieur, Sottegen, Belgium.
VAN MATER, EVERETT PIKE, '97. 9 Convier St., Rutherford, N. Y.
VAN METER, CHARLES FARRAGUT, '87. Address not known.
VANNAN, PAUL ANTRIM, '07. 308 Terry St., Danville, Pa.
VAN NORDEN, RUDOLPH WARNER, A.B., M.E., '96. Consulting Engr. (2) and (3) 510-512 Rialto Bldg., San Francisco, Cal. (1) 1329 Clay St., San Francisco, Cal. Mem. Am. Soc. Civil Eng., Fellow Am. Ins. Elec. Engr.
VAN NOSTRAND, LEONARD GREEN, M.E., '06. 729 Monroe Ave., Scranton, Pa.
VAN STONE, FREDERICK JONAS, '79. Address not known.
VAUTROT, LOUIS R., M.E., '12. Elec. Engr. (2) and (3) Cutler Hammer Mfg. Co., Milwaukee, Wis. (1) 183 14th St., Apt. 7, Milwaukee, Wis. Tau Beta Pi, Eta Kappa Nu.
VAN TRUMP, CHAS. R., M.E., '89. Retired. 305 W. 8th St., Wilmington, Del. A. S. M. E., A. I. E. E.
VAN VALKENBURGH, HAROLD BLISS, M.E., '12. Western Elec. Co., East Orange, N. J.
VAN VALKENBURGH, RALPH D., M.E., '01. Mech. Engr. Greene, Chenango Co., New York City. A. S. M. E., A. I. M. E., F. & A. M.
VAN VALKENBURGH, RICHARD MEARS, M.E., '15. Industrial Accident Prevention. (1) Greene, N. Y. (2) and (3) 15-17 Commerce St., Baltimore, Md.
VAN VLEET, MONTGOMERY SANFORD, M.E., '04. (1) 1050 University Ave., Rochester, N. Y. (2) and (3) 608 Main St., E. Rochester, N. Y.
VAN VORST, JULIAN PURSE, '08. Box 1010, Houston, Texas.
VAN WAGENEN, HENRY TRACY, M.E., '03. 121 York St., New Haven, Conn.
VAN WICKLE, GEORGE STOUT, JR., '03. Manati, P. R.
VAN WINKLE, WALTON, M.E., '06. (1) Box 654, Asheville, N. C. (2) and (3) Desert Land Board, Salem, Ore.
VAN ZILL, FRANK M., '06. 19 Eagle St., Schenectady, N. Y.
VATET, OSCAR V., B.Arch., '05. Architect. (2) and (3) 15 E. 40 St., New York City. (1) Pleasantville, N. Y.
VAUGHN, LELAND ALEXANDER, '09. (1) Cuyahoga Falls, Ohio. (2) Sec. and Asst. Mgr., The Turner, Vaughn & Taylor Co.
VELARDE Y COBIAN, MANUEL CARLOS, M.E., '04. Apartado 1273, Lima, Peru.
VENCILL, ALBERT LEANDER, M.E., '07. Patent Attorney for Union Switch and Signal Co. (2) and (3) Swissvale, Pa. (1) 510 McNair St., Wilkinsburg, Pa.
VERITY, CALVIN WILLIAM, M.E., '11. Asst. to General Supt. (2) and (3) American Rolling Mill Co., Middletown, O. (1) Ninth and Main St., Middletown, O.
VERY, WILLIAM RICHARD MCKEY, '13. 119 Elm St., New Rochelle, N. Y.
VESER, LUCIUS OTTO, M.E., '03. (1) 183 Hollinger Ave., Akron, O. (2) and (3) Care Aluminum Co. of America, Massena, N. Y.
VEIT, KENNETH, '10. 17 W. 71 St., New York City.
VICKERS, JOHN HAROLD, '17. 5739 Blackstone Ave., Chicago, Ill.
VIEDT, HAROLD BERTRAM, M.E., '15. 25 Western Ave., Warristown, N. J.
VIDAL, F. F., M.E., '16. Guayama, P. R.
VILES, LAWRENCE MOTLEY, M.E., '04. 1236 Dearborn Ave., Chicago, Ill.
VINCENT, CHARLES ROY, M.E., '08. 1404 Pioneer Bldg., St. Paul, Minn.
VINCENT, HAROLD BLANCHARD, M.E., '04. Operating Engr. (2) and (3) Day & Zimmermann, 611 Chestnut St. (1) 6926 McCalhan St., Philadelphia, Pa. A. I. E. E., M. E. L. A., Penn. Gas Assn.
VINCENT, JEFFERSON DAVIS, M.E., '11. War Dept., U. S. Army, Washington, D. C.
VINCENT, LOUIS L., M.E., '11. Manila Lt. & Ry. Co., Manila, P. I.
VINCENT, SIDNEY COOMBE, M.E., '05. (1) Waterbury, Conn. (2) and (3) Industrial Bldg., Baltimore, Md.
VINCENT, WILLIAM GERMAIN, JR., M.E., '04. 52-11 St., San Francisco, Cal.
VIVO, SALVADOR, M.E., '11. 315 Packer Ave., S. Bethlehem, Pa.
VOCKE, CHAS. WILLIAM, M.E., '00. Development of Automatic Gas Water Heater. 9 Monroe St., Ridgewood, N. J.
VOEGE, ADOLPH LAW, M.E., '99. 212 Penn St., Brooklyn, N. Y.
VOETTER, THOMAS W., M.E., '92. R. F. D. 6, Ft. Wayne, Ind.
VOHR, JOHN HENRY, M.E., '16. 608 S. Linden Ave., Pittsburgh, Pa. A. I. E. E.
VOLLRATH, JEAN CARL, M.E., '17. 1729 North 6th St., Sheboygan, Wis.
VON DER LIPPE, ARTHUR, '08. 8 & Olive St., St. Louis, Mo.
VON DER LIPPE, ERNEST CARL FRIEDERICK, '07. Chemical Bldg., St. Louis, Mo.
VONNEGUT, ANTON, M.E., '05. 43 S. Meridian St., Indianapolis, Ind.
VOORHEES, ALBERT COERT, M.E., '13. 2 Mermaid Court, Long Beach, Cal.
VOORHEES, FRANK DURYEA, A.B., '01. 151 Jewett Ave., Jersey City, N. J.
VOSE, CHARLES REDFIELD, M.E., '14. 317 W. 99 St., New York, N. Y.
VOSE, ROBERT EMERY, M.E., '03. Coast Art School, Ft. Monroe, Va.
VREELAND, CHARLES MUSK, '89. 239 Washington St., Jersey City, N. J.
VREELAND, GEORGE WASHINGTON, M.E., '98. (1) 333 N. 5th St., Steubenville, O. (2) and (3) Supt. Blast Furnaces, Carnegie Steel Co., Steubenville, O. Am. I. & S. Inst.
VROOMAN, ISAAC HENRY, JR., M.E., '02. 294 Hamilton St., Albany, N. Y.
VROOME, ELWOOD PEARSON, '13. Gould Place, Caldwell, N. J.
WADE, HENRY NAZER, M.E., '14. Development Engr. (1) 386 22d St., Milwaukee, Wis. (2) Cutler-Hammer Mfg. Co., 12th St. and St. Paul Ave., Milwaukee, Wis. Eta Kappa Nu.
WADMAN, HAROLD ATHELSTANE, M.E., '13. Insp. Newport News Shipbuilding & Dry Dock Co. (2) and (3) Newport News, Va. (1) 216 33d St., Newport News, Va.
WADSWORTH, EDWARD ARTHUR, M.E., '04. 276 Jelliff Ave., Newark, N. J.
WAGNER, DWIGHT HORNANS, B.Arch., '98. (1) Leatherwood, Wheeling, W. Va. (2) and (3) Sec. Wheeling Corrugating Co., Wheeling, W. Va.
WAGNER, EFFINGHAM BUCKLEY, M.E., '06. Elec. Engr. (2) and (3) Lehigh Valley Coal Co., Wilkes-Barre, Pa. (1) 15 N. Franklin St., Wilkes-Barre, Pa. A. I. E. E.
WAGNER, GEORGE ANDREW, '06. Water Valley, Miss.
WAGNER, GEORGE FRANCIS, M.E., '93. Address not known.
WAGNER, JOHN LAWRY, '95. Vice-Pres. and Treas. The Pulmoelectric Machine Co. (1) 704 Lodi St., Syracuse, N. Y. (2) and (3) 581 S. Clinton St., Syracuse, N. Y.
WAIGHT, ARMSTEAD TAYLOR, M.E., '08. Mt. Vernon, O.
WAIT, CONANT, M.E., '12. Asst. Sales Mgr. Motor Truck Dept. (2) and (3) 1470 Michigan Ave., Chicago, Ill. (1) 4919 Dorchester Ave., Chicago, Ill.
WAIT, JUSTIN FEDERAL, M.E., '16, M.M.E., '17. (1) and (3) 204 5th St., Niagara Falls, N. Y. (2) Hooker Electrochemical Co., Niagara Falls, N. Y.
WAIT, WILLIAM BARKER, M.E., '08. 5439 Samson St., Philadelphia, Pa.
WAKELY, ARTHUR WEEKS, M.E., '11. Sec. Paul H. Davis & Co., Investment, Bankers and Underwriters. (1) 5102 Kenwood Ave., Chicago, Ill. (2) and (3) 39 S. La Salle St., Chicago, Ill. Western Ry. Club.
WAKEMAN, ROBERT PEEL, '72. Genealogist. Southport, Conn.
WAKEMAN, SAMUEL WILEY, M.E., '99. Fore River Shipbldg. Co., Quincy, Mass.
WALBRAN, CHRISTOPHER JAMES, M.E., '06. Engrg. Asst. Traffic Dept., West Union Tel. Co. (2) and (3) 195 Broadway, New York City. (1) 544 E. 21st St., Brooklyn, N. Y.
WALBRIDGE, GEORGE HICKS, M.E., '90. Vice-Pres. Wm. P. Bonbright & Co., Inc., Investment Bankers. (1) 64 E. 66th St., New York City. (2) and (3) 25 Nassau St., New York City.
WALBRIDGE, LESTER BORDEN, '09. Salesman for International Motor Co. 57th and Broadway, New York City.
WALBRIDGE, RODNEY OLIN, M.E., '10. (1) 532 Atlantic Ave., Brooklyn, N. Y. (2) and (3) 177 Rugby Rd., Brooklyn, N. Y.
WALDER, GEORGE HENRY, M.E., '09. 641 Walker St., Milwaukee, Wis.
WALDO, EDWARD H., M.E., '90. Asst. Prof. Elec. Eng. (2) and (3) E. E. Dept., Univ. of Ill., Urbana. (1) 802 W. Illinois St., Urbana, Ill. A. I. E. E., A. A. A. S., Phi Beta Kappa, Tau Beta Theta, H. K. N.
WALDRON, HENDRICK ALBERTSON, '99. Address not known.
WALKER, ARCHIE DEAN, '08. 807 Hennepin Ave., Minneapolis, Minn.
WALKER, EDWARD EVERETT, '03. Erie Mall. Iron Co., Erie, Pa.
WALKER, EMERY LAFAYETTE, M.E., '02. (1) 250 E. Milwaukee Ave., Wanwatosa, Wis. (2) and (3) 948 Adams Ave., Berlin, Wis.
WALKER, GEORGE WILFRED, M.E., '04. District Sales Mgr., Cooper Hewitt Elect. Co. (2) and (3) 1009 First Nat. Bank Bldg., Cincinnati, O. (1) 175 Woolper Ave., Cincinnati, O. Illuminating Engrg. Soc.
WALKER, JAMES BLAINE, LL.B., '12. Felt Bldg., Salt Lake City, Utah.
WALKER, PERLY F., M.M.E., '01. Dean, School of Engrg., Univ. of Kansas. 1301 Ohio St., Lawrence, Kansas. A. S. M. E., A. A. A. of Sci., S. P. E. E., Kansas Engrg. Soc., Sigma Xi, Tau Beta Pi.
WALL, ROBERT EARLE, M.E., '10. (1) 556 Public Ave., Beloit, Wis. (2) and (3) Fairbanks Morse Co., Richmond, Va.
WALLACE, DUDLEY WALKER, M.E., '13. 1195 Union St., Brooklyn, N. Y.
WALLACE, FREDERICK ASHBY, '05. 107 N. 34 St., Philadelphia, Pa.
WALLACE, FRANK RICH, M.E., '11. 140 Pomeroy Ave., Pittsfield, Mass.
WALLACE, LINDSAY HUGH, '06. 1551 Columbus Rd., Cleveland, O.
WALLACE, ROY WESTON, M.E., '01. 911 N. 9 St., Lafayette, Ind.
WALLACE, WILLIAM LEWIS, M.E., '06, M.M.E., '07. 645 N. 8th St., Manitowoc, Wis.
WALLACE, WILLIAM S., M.E., '10. Sales Engr., Burke Elec. Co. (2) 739 Oliver Bldg., Pittsburgh, Pa. (1) and (3) 321 S. Evaline St., Pittsburgh, Pa. Engrs. Soc. of West. Pa.
WALLANT, MURRAY FRANK, '11. Address not known.
WALLENBECK, EDWARD THOMAS, '89. R. F. D. 7, Ithaca, N. Y.
WALLIS, HARRY FOULMAN, '13. Box 38, Girard, Ohio.
WALLOWER, EDGAR ZOLLINGER, M.E., '07. 336 High St., Lockport, N. Y.
WALSER, ARTHUR CYRUS, '10. (1) New Brighton, N. Y. (2) and (3) Dime Sav. Bank Bldg., Detroit, Mich.
WALSH, FRANK LAWSON, M.E., '95. Railway Postal Clerk, U. S. Mail Service. 127 W. Ceceil St., Springfield, O.
WALSH, JOSEPH JAMES, '98. 148 Buttles St., Columbus, O.
WALTER, ARTHUR LESLIE, '88. Harvey, Ill.
WALTHER, ARTHUR CHRISTIAN, M.E., '97. 776 Mt. Prospect Ave., Newark, N. J.
WALTON, ALBERT, M.E., '02. Consulting Engineer. (1) Brookline, Mass. (2) and (3) 38 Rock St., Fall River, Mass.
WALTON, ALEXANDER WILLIAMSON, '11. 1227 W. 8 St., Cincinnati, O.
WALTON, WILLIAM HECKMAN, '87. Address not known.
WALZER, JOSEPH, M.E., '11. 188 S. Commons St., W. Lynn, Mass.
WAMBAUGH, RUSSELL HARRISSON, M.E., '13. Asst. Eng., Vice-President's Office. (1) 1116 E. 20 St., Baltimore, Md. (2) and (3) Room 501, B. & O., R. R. Bldg., Baltimore, Md. Engineer's Club of Baltimore.
WAND, ERNEST OTHNEIL PESTER, '05. (2) and (3) 1214 McCormack Bldg., Chicago, Ill. (1) 523 N. Elmwood Ave., Oak Park, Ill.
WANG, PIH, M.E., '09. (1) Pekin Kalgan Ry., Nankow, China. (2) and (3) 123 Dryden Rd., Ithaca, N. Y.
WANG, SHING TSO, M.E., '11. Address not known.
WANNER, WALTER E., M.E., '13. Master Mechanic. (2) and (3) State Sanitorium, Hamburg, Pa. (1) 119 Herkimer St., Buffalo, N. Y.
WARD, CHARLES ARCHIBALD, M.E., '02. Address not known.
WARD, DIEDERICH HANFIELD, '11. Prospect Ave., Hackensack, N. J.
WARD, HENRY A., M.E., '98. Sterling Blower Co., Hartford, Conn. 300 Vine St., Hartford, Conn.
WARD, J. CARLTON, JR., M.E., '14. Mech. Eng. (2) and (3) Niles Tool Works, Hamilton, O. (1) Y. M. C. A., Hamilton, O. A. S. M. El.
WARD, JOSEPH W., M.E., '13. Sales Engineer. (1) Danbury, Conn. (2) and (3) Taylor Instrument Co., Rochester, N. Y.
WARD, LAWRENCE COLIN, '06. Address not known.

WARD, OSSIAN PEAY, M.E., '96. Partner, Ward & Glossop, Archts. and Engrs. (2) and (3) 1500 Lincoln Bldg., Louisville, Ky. (1) 1243 First St., Louisville, Ky.

WARDEN, HERBERT ANDREW, '02. 14 S. Water St., Newburgh, N. Y.

WARDLAW, GEORGE A., M.E., '93. Editor *Electric Record*. (2) and (3) 114 Liberty St., New York City. (1) 12 Seneca Pl., Upper Montclair, N. J.

WARDWELL, ARTHUR SOPER, M.E., '06. 541 Lincoln Pl., Brooklyn, N. Y.

WARDWELL, WILLIAM HENRY, M.E., '97. Consulting Engr. (2) and (3) 413 New Birks Bldg., Montreal, P. Q. (1) 450 Victoria Ave., Westmount, P. Q.

WARDWELL, J. S., '15. 700 N. Washington St., Rome, N. Y.

WARE, LYMAN EUGENE, B.M.E., '77. Engineering. (2) 201 Devonshire St., Boston. Mass. (1) and (3) Norfolk, Mass.

WARFIELD, WILSON LAING, M.E., '15. 107 Chestnut Ave., Takoma Park, D. C.

WARNER, AUSTIN MCRAVEN, M.E., '05. Farmer. Russum, Miss.

WARNER, CHARLES EMORY, '92. Portland, Ore.

WARNER, CHARLES LATHROP, '95. Titusville, Pa.

WARNER, EDWARD HENDERSON, '94. Whitesboro, N. Y.

WARNER, FREDERICK THORNE, '10. 235 State St., Hackensack, N. J.

WARNER, IRVING, M.E., '04. 1016 Rodney St., Wilmington, Del.

WARNER, KENNETH BAIRD, '16. Care F. E. Warner, Warner Bros. Co., Bridgeport, Conn.

WARNER, LEA PUSEY, M.E., '03. 810 Thos. Ave., Riverton, N. J.

WARNER, MAURICE LEE, '06. 47 Maple Ave., Beacon Falls, Conn.

WARNER, MUNROE FRANK, M.E., '11. Standard Securities Corp., 729 Palace Bldg., Minneapolis, Minn.

WARNER, RAYMOND CURTIS, M.E., '07. 500 Westinghouse Bldg., Pittsburgh, Pa.

WARNER, ROY CRANDALL, '98. Naugatuck, Conn.

WARNER, ROBERT LYON, M.E., '92. Banker. (2) and (3) 50 Congress St., Boston, Mass. (1) Concord, Mass. A. S. M. E.

WARREN, CHESTER INGERSOLL, M.E., '05. Fuller & Warren Co., Troy, N. Y.

WARREN, DAVID M., B.S.A., '11. Livestock farmer White Hall Farm, Warrenton, Va.

WARREN, GEORGE SESSIONS, M.E., '05. (2) Chief Engr., Sharon Steel Hoop Co., Sharon, Pa. (1) and (3) 2 Euclid Ave., Sharon, Pa. A. S. M. E., Engr's. Soc. West, Pa.

WARREN, JOHN BENJAMIN, '73. 220 Kearney Ave., Newark, N. J.

WARREN, WESLEY WIRT, '96. 221 Washington St., Butte, Mont.

WASHBURN, MORGAN, JR., M.E., '14. (1) 1615 Benson Ave., New York City. (2) and (3) Elec. Engr., Cutler-Hammer Mfg. Co., Milwaukee, Wisc. Eta Kappa Nu, Amer. Inst. of Elec. Engrs.

WASON, CHARLES WILLIAM, '76. (1) 9209 Euclid Ave. (2) and (3) 1218 Citizens Bldg., Cleveland, O.

WATERALL, HOWARD LEHMAN, '06. Paint Mfg., Trout and Mechanic St., Camden, N. J.

WATERBURY, CLARENCE MCINTOSH, M.E., '02. Whitesboro, N. Y.

WATERBURY, JAMES EDWIN, '10. Oriskany, N. Y.

WATERMAN, FRANK NEHEMIAH, M.E., '89. Consulting Engr. (2) and (3) 100 Broadway, New York City. (1) 25 Norwood Ave., Summit, N. J. Fellow A. I. E. E., Men Ins. Radio E., Soc. Automobile Eng., Am. Elect. Chem. Co.

WATERS, ERNEST JOSEPH HILL, '07. Address not known.

WATERS, HARRY HILL, M.E., '13. (1) 1108 N. 2d, Clinton, Iowa. (2) Instructor, Cornell Univ. (3) College Ave., Ithaca, N. Y.

WATERS, HENRY LANGWORTHY, M.E., '00. Weston Elec. Co., New York City.

WATERS, HERMAN BIERCE, M.E., '03. General Mgr., Beaver River Power Co. (1) (2) and (3) Richfield, Utah. A. I. E. E.

WATKINS, ARTHUR CALDWELL, M.E., '15. Engineer. (1) 1972 Ford Drive, Cleveland, Ohio. (2) and (3) Warner and Swasey Co., Cleveland, Ohio.

WATKINS, EDWARD HOFFMAN, M.E., '17. 2219 St.Paul St., Baltimore, Md.

WATKINS, WARNER MERRIWEATHER, M.E., '06. 84 State St., Boston, Mass.

WATSON, EDWARD FISK, M.E., '14. (1) 414 W. 121 St., New York City. (2) and (3) Roscoe, N. Y.

WATSON, HARRY DIXSON, '92. 10 Bridge St., New York City.

WATSON, HUBERT LEIGH, M.E., '11. (1) 111 University Ave., W. Lafayette, Ind. (2) Purdue Univ., W. Lafayette, Ind.

WATSON, ROBERT SEDGEWICK, '11. 44 Stuyvesant Pl., New Brighton, N. Y.

WATSON, WILLIAM, M.E., '93. 308 Whalley Ave., New Haven, Conn.

WATSON, WILLIAM HENRY, M.E., '12. 5812 Rural Ave., Pittsburgh, Pa.

WATT, CRAIG MCCLELLAND, '04. Asst. Gen'l Mgr. Coal & Coke Co., Land Title Bldg., Philadelphia, Pa.

WATT, HAROLD WOODRUFF, M.E., '07. Engr., and Electric Distribution, (1) 137 Washington St., Mt. Vernon, N. Y. (2) and (3) Care of Westchester Lighting Co., Mt. Vernon, N. Y. A. I. E. E., N. E. L. A.

WATT, ROLAND MCKINLEY, M.E., '17. 433 East Buchtel Ave., Akron, Ohio.

WATTS, ALFRED ALLAN, '95. 50 Church St., New York, N. Y.

WATZEK, JOHN WHITTIER, JR. M.E., '14. Manufacturing. (1) 501 Montgomery Drive, Portland, Ore. (2) and (3) Williamette Iron & Steel Wks., Portland, Ore.

WEAVER, JOSEPH BRIGGS, M.E., '02. Newport News Ship Bldg. Co., Newport News, Va.

WEAVER, THOMAS DESMOND, M.E., '97. 220 S. Elmer St., Sayre, Pa.

WEBB, CHARLES WAYLAND, M.E., '02. Member of J. W. S. Webb & Sons, Real Estate, Brokers and Operators. (1) 2056 Cornell Road, Cleveland, Ohio. (2) and (3) 459 The Arcade, Cleveland, Ohio.

WEBB, HERBERT GREAVES, '05 48 Woodlawn Ave., Glen Ridge, N. J.

WEBB, HENRY PUSEY, '98. Said to be insane in insane hospital near Philadelphia.

WEBB, JAMES ARCHER, '09. J. W. Webb & Sons, Real Estate Brokers, (1) 217 Cummington Rd., Cleveland, Ohio. (2) and (3) 459 The Arcade, Cleveland, Ohio.

WEBB, JOHN LAMAR, '09. 2 Ferncliff Ave., Springfield, O.

WEBB, LOUIS ALBERT, M.E., '04. 614 E. Colo. St., Pasadena, Cal.

WEBBER, FREDERICK CHRISTIAN, M.E., '95. 10 Grammercy Pk., New York, N. Y.

WEBER, HERMAN RUDOLPH, M.E., '95. 317 Germ. Am. Trust Bldg., Denver, Colo.

WEBER, RUDOLF LORENZ, M.E., '05. Eng. Equip. and Power, Bd. Control K. C. Rys., (2) and (3) 1500 Grand Ave., Kansas City, Mo. (1) 518 Union Ave., Paterson, N. J. A. I. E. E.

WEBER, THEODORE GEORGE, M.E., '10. Asst. Supt. Works Central Union Gas Co. (2) and (3) 905 E. 138 St., New York City. (1) 1339 University Ave., New York City. American Gas Institute.

WEBSTER, EARNEST HERBERT, '04. Address not known.

WEBSTER, GEORGE PILSBURY, M.E., '07. 52 Grand Ave., Lestershire, N. Y.

WEBSTER, LOUIS DAVID, M.E., '08. 6444 Ellis Ave., Jackson Pk., Chicago, Ill.

WEBSTER, TOWNER KEENEY, '03. Vice-Pres. Webster Eng. Co. (1) 1403 Maple Ave., Evanston, Ill. (2) and (3) Stock Exchange Bldg., Chicago, Ill.

WEBSTER, WILLIAM REUBEN, M.E., '90. Vice-Pres. Bridgeport Brass Co. (1) 208 Woodlawn Ave. Bridgeport. (2) and (3) Bridgeport Brass Co. A. S. M. E., A. S. I. M., A. S. A. E., Am. Inst. Mts.

WECHSLER, JOSEPH, M.E., '07. Barge Canal Office, Rome, N. Y.

WEED, RUDOLPH WOODRUFF, JR., M.E., '09. Detroit Steel Products Co. (1) 601 W. 115 St., New York City. (2) 30 E. 42 St., New York City.

WEEDON, WELFIED ARTHUR, '07. Woolloongabba, Brisbane, Australia.

WEGENER, FRANCIS ADOLPH, '12. Works Engineer. (1) Gloucester, N. J. (2) and (3) Welsbach Co., Gloucester, N. J. A. S. M. E.

WEGMAN, ERNEST CONRAD, M.E., '10. Research Engr. (1) 1910 S. Springfield Ave., Chicago. (2) and (3) Western Elec Co., Chicago, Ill.

WEHR, FREDERIC CARL, M.E., '12. 3018 Grand Ave., Milwaukee, Wis.

WEI, E. FAH, M.E., '12. Peking Univ. (1) 3 Double Pond St., Huchow, China. (2) and (3) Peking, China.

WEIDENTHAL, HAROLD GEORGE, '13. Engr. Heat Treatment and Research Dept., Upson Nut Co., Cleveland, Ohio. 3778 W. 33 St., Cleveland, Ohio. Cleveland Eng. Soc., Amer. Soc. for Test. Mat.

WEGG, DAVID SPENCER, JR., M.E., '12., M.M.E., '14. 710 Walker Bank Bldg., Salt Lake City, Utah.

WEIDNER, PAUL GUSTAVUS, M.E., '02. Ass't Supt. (2) Ludlow Manufacturing Associates. (1) and (3) 50 North St., Ludlow, Mass. A. S. M. E.

WEIL, ALBERT, '13. 114 S. St., Asaph St., Alexandria, Va.

WEINBERGER, ABRAHAM BERNARD, M.E., '14. 17 W. 24th St., New York City.

WEINER, EDWIN MORRIS RICHARD, M.E., '06. 27 Spring St., Kingston, N. Y.

WEISER, RICHARD MATHEE, M.E., '14. National Blank Book Co., Holyoke, Mass.

WEISS, HERBERT ALBERT JULIUS, M.E., '12. Asst. Prof. Drawing. (2) and (3) Georgia School Tech., Atlanta, Ga. (1) 1 Harris St., Rochester, N. Y. A. S. M. E.

WEISS, PAUL ALBERT HENRY, M.E., '16. With Central Hudson Gas & Elec. Co. (2) and (3) Poughkeepsie, N. Y. (1) 1 Harris St., Rochester, N. Y.

WELBORN, EDGAR CALVERT, M.E. '03. University Club, Milwaukee, Wis.

WELCH, ALBERT EDWARD, M.E., '13. 1421 Arch St., Philadelphia, Pa.

WELCH, HAROLD FRANKLIN, M.E., '10. (1) 850 W. 179 St., New York City. (2) and (3) 538 Westfield Ave., Westfield, N. J.

WELCH, LEON COWLES, M.E., '06. Div. Supt., Cygnet Div. The Buckeye Pipe Line Co. (1) 201 N. Washington St. (2) and (3) 137 West North St., Lima, O. A. S. M. E., Elec. Engr. Soc.

WELLER, GEO. LARUE, M.E., '97. Sec. Treas., General Specialties Co. (1) Anchorage, Ky. (2) and (3) 217 Keller Bldg., Louisville, Ky.

WELLES, GEORGE EDWARD, '07. 145 Linwood St., Riverside, Cal.

WELLES, HALSEY VANDERBILT, M.E.. '13. American Blower Co., 28 Davenport St., Detroit, Mich.

WELLMAN, HOLLEY GARFIELD, '05. (1) 8803 Euclid Ave., Cleveland, O. (2) and (3) 609 Rockefeller Bldg.

WELLHOUSE, FREDERICK JAMES, M.E., '09. (1) 15 Hillside Rd., Highlands, Mass. (2) and (3) Commer. Engr. Switchboards, West. Elec. Mfg. Co., Boston, Mass.

WELLMAN, SAMUEL KNOWLTON, M.E., '14. (1) 11200 Edgewater Drive, Cleveland, O. Wellman, Seaver Morgan Co., (2) and (3) 7000 Centra Ave. Cleveland Eng. Soc.

WELLMAN, WALTER MORTON, 13. Paymaster, Huntsville Knitting Co., Huntsville, Ala.

WELLS, ARTHUR STANTON, M.E., '14. Electrical Engr. with John A. Stevens, Eng'r. (1) Christmas Cove, Maine. (2) and (3) Sun Bldg., Lowell, Mass.

WELLS, EDGAR CHARLES, '99 Duluth, Minn.

WELLS, HUGO DANIEL, '02. 87 "B" St., Salt Lake City, Utah.

WELLS, JOHN HILBISH, M.E., '03. Port Clinton, Ohio.

WELLS, STANFORD, '05. Am. Locomotive Wks., Bolton Landing, N. Y.

WELLS, WAYNE BANGLEY, '07. (1) 1331 Fairmount St., Washington, D. C. (2) and (3) Patent Office, Washington, D. C.

WELLS, WILLIAM KELLOGG, M.E., '12. 1230 Virginia Ave., Birmingham, Ala.

WELSH, EVERETT CARTWRIGHT, M.E., '05. Mech. Engr. (1) Bayside, Long Island. (2) and (3) Care West. Church Kerr Co., New York City. Ill. Eng. Soc.

WENDT, EDGAR FORSYTH, M.E., '11. Sales Mgr. (2) Geo. L. Squier Mfg. Co., Buffalo, N. Y. (1) and (3) 746 Lafayette Ave., Buffalo, N. Y. A. S. M. E.

WENTZ, JOHN LEISEURING, M. E., '98. Union League Club, Philadelphia, Pa.

WERNER, EDWARD ALPHONSO, JR., '98. 528 W. Peachtree St., Atlanta, Ga.

WERNER, RUDOLPH CHARLES, JR., M.E., '08. (1) 7014 Hilldale Ave., Chicago, Ill. (2) and (3) 143 4 St., Milwaukee, Wis.

WERNICKE, CARL LEOPOLD, M.E., '03. (1) 933 Northwestern Bank Bldg., Portland, Ore. (2) and (3) 604 Wilcox Bldg., Portland, Ore.

WESLEY, CHARLES FREDERICK, M.E., '10. 449 Kaighns Ave., Camden, N. J.

WESSINGER, HENRY WILLIAM, M.E., '10. 502 Electric Bldg., Portland, Ore.

WESSLING, ALBERT GUSTAVE, M.E., '93. Pres. and Gen'l Mgr., Wessling Bros. Fdy. Co. (1) and (3) 221 McCormick Place, Cincinnati, O. (2) McLean & Sherman Aves., Cincinnati, O.

WESSON, DOUGLAS BERTRAM, '06. Long Meadow, Springfield, Mass.

WEST, AUSTIN WALKER, M.E., '15. Tunnell Hill, Ga.

WEST, CHARLES CAMERON, M.E., '00. Manitowoc Ship Bldg. Co., Manitowoc, Wis.

WEST, CHARLES SUMNER, '05 Lakeville, N. Y.

WEST, ERASTUS LOVETTE, M.M.E., '00. Pres. Reading Transit, & Light Co., and Metropolitan Elec. Co. (1) 604 N. Fifth St., Reading, Pa. (2) 18 South Fifth St., Reading, Pa. (3) P. O. Box 838, Reading, Pa.

WEST, FRANK, M.E., '04. 114 Augustine Ave., Schenectady, N. Y.

WEST, JOHN ACKROYD, JR., M.E., '90. 1308 Knoxville Ave., Peoria, Ill.

WEST, LIVINGSTON DIMMICK, M.E., '07. Power Engr., United Elec. Lt. & W. Co. (1) 195 Columbia Blvd., Waterbury. (2) and (3) 807 Lilley Bldg., Waterbury, Conn.

WEST, LOUIS COULTON, '06. Address not known.

WESTBROOK, C. R., '13. 42 Franklin St., Ogdensburg, N. Y.

WESTCOTT, CHARLES DRAKE, '95. (1) 1223 Vermont Ave., Washington, D. C. (2) and (3) 426 5 St., Washington, D. C.

WESTERVELT, THOMAS ST. JOHN, M.E., '96. (1) 5 St. and Montgomery Ave., Philadelphia, Pa. (2) 125 School St., Germantown, Pa.

WESTINGHOUSE, HENRY HERMAN, '75. 165 Broadway, New York City.

WESTON, EDWIN HOYT, '11. Portyfort, Pa.

WESTON, WILLIAM HENRY, B.S., '85. Address not known.

WETHERBEE, ASHUR URL, M.E., '08. Chief Engr., and Asst. Supt. (1) 25 Sugar St., Niagara Falls, N. Y. (2) and (3) Niagara Alkali Co., Niagara Falls, N. Y.

WETHERILL, FRANK BRENTFORD, M.E., '10. 663 N. 33 St., Philadelphia, Pa.

WETHERILL, JOHN LARKIN, M.E., '07. 14 and Potter Sts., Chester, Pa.

WETZEL, CHARLES HOWARD, M.E., '13. Wayne Iron Wks. (1) 307 Summit Ave., Wayne, Pa. (2) and (3) 818 Commercial Trust Bldg., Philadelphia, Pa.

WHALEY, WILLIAM BURROUGHS SMITH, M.E., '88. 1012 Tremont Bldg. Boston. Mass.

WHARTON, HUGH MORRISON, '91. 15 and Chestnut Sts., Philadelphia, Pa.
WHEELER, HARLEY TRASK, M.E., '11. (1) Clermont, Fla. (2) and (3) 2619 Victor St., Kansas City, Mo.
WHEELER, HARRY LINDSAY, M.E., '13. Asst. Cashier. (1) 5325 University Ave., Chicago, Ill. (2) and (3) Union Trust Co., Chicago, Ill.
WHEELER, HENRY DUNCAN, M.E., '13. 2260 Elston Ave., Chicago, Ill.
WHEELER, HORATIO QUINCY, M.E., '14. 11 Deering St., Portland, Me.
WHEELER, JOHN A. M.E., '03, M.M.E., '06. County Engineer and Surveyor, Lyman Co., S. D. Deputy State Surveyor. (1) (2) and (3) Oacoma, S. D.
WHEELER, NEYRON MARSHALL, '14. Attica, N. Y.
WHEELER, NUTELLUS CLINTON WOODBURY, '87. 107 S. Jefferson St. Peoria, Ill.
WHEELER, WILBUR RICHARD, C.E., '12. 200 S. Grove Ave., Oak Park, Ill.
WHEELER, WILLIAM JOHNSTON, M.E., '17. 170 Elbertson St., Elmhurst, New York City.
WHELAND, ZENAS WINSOR, M.E., '96. Chattanooga, Tenn.
WHELESS, EAKIN L., M.E., '16. (1) 861 Jordan St., Shreveport, La. (2) and (3) Allen Mfg. Co., Shreveport, La.
WHINERY, SAMUEL BRENT, M.E., '99. Mechanical Eng., Agent Pumping Machinery. (1) 203 Glenwood Ave., E. Orange, N. J. (2) and (3) 95 Liberty St., New York City.
WHIPPLE, CYRUS AVERY, M.E., '03. Box 423, Bremerton, Wash.
WHITAKER, NELSON PRICE, '96. Wheeling, W. Va.
WHITE, CARL FOSTER, B.Arch., '05. 821 Citizens Bldg., Cleveland, O.
WHITE, DEGRAY, M.E., '17. Butler, N. J.
WHITE, HAROLD ELIJAH, M.E., '98. Controller Eng. (1) 4 Norman Rd., Mt. Clair, N. J. (2) and (3) Crocker Wheeler Co., Ampere, N. J. A. I. S. E., A. S. M. E.
WHITE, HARRY CLINTON, M.E., '95. 409 Park St., Upper Montclair, N. J.
WHITE, HENRY GEORGE, '93. I. M. Ludington Sons Inc., 119 Powers Bldg., Rochester, N. Y.
WHITE, HENRY GRAVES, M.E., '00. Real Estate, Coraopolis, Penn.
WHITE, JAMES DUGALD, A.B., '11. Hemphill White & Chamberlain, 37 Wall St., New York City.
WHITE, JOHN BEAVER, M.E., '99. London Branch J. G. White Corp. (2) and (3) Beaver, White & Co., Bonds and Inv. Sec's. Austin Friars House, London, Eng., and 120 Broadway, New York City. (1) 34 Abbey Rd., London, Eng.
WHITE, JOHN JAY, JR., M.E., '05. Address not known.
WHITE, LOUIS EUGENE, M.E., '94. Purchasing Agent and Treasurer. (1) Albion, Mich. (2) and (3) Gale Mfg. Co., Albion, Mich. A. S. M. E.
WHITE, RICE WARREN, M.E., '08. Domestic Utilities Co., 149 Broadway, New York City.
WHITE, ROLLIN HENRY, M.E., '94. Cleveland Motor Plow Co., Cleveland, O. A. I. E. E.
WHITE, THEODORE PARKMAN, '04. Engineer, Telephone Traffic. (1) 65 Walnut St., Rutherford, N. J. (2) and (3) Care Amer. Telephone and Telegraph Co., New York City.
WHITE, WILLIAM MORSE, M.E., '08. (1) 918 Highland Ave., Chester, Pa. (2) and (3) 2424 W. 4 St., Chester, Pa.
WHITED, EDMUND WILLIS, M.E., '12. (1) 5916 Alder St., Pittsburgh, Pa. (2) and (3) 2116 No. 3 St., Harrisburg, Pa.
WHITEHEAD, JAMES FRAZER, '13. 417 Seminole Ave., Detroit, Mich.
WHITEHEAD, JAMES HAROLD, M.E., '06. Salesman. (1) 603 Hillcrest Ave., Westfield, N. J. (2) and (3) Whitehead Bros., 537 W. 27 St., New York City.
WHITEHEAD, JOHN LEWIS, '96. 24 Sagamore St., Boston, Mass.
WHITEHEAD, LYMAN TIBBALS, '96. 435 W. 5 St., Erie, Pa.
WHITFIELD, GEORGE HILLMAN, M.E., '96. (1) 27 Hillside Ave., Montclair, N. J. (2) and (3) 1712 Grove Ave., Richmond, Va.
WHITING, FRANK RICE, '13. Secy. and Treas. Whiting Lumber Co. (1) 6321 Lancaster Ave., Overbrook, Philadelphia, Pa. (2) and (3) 1644 Land Title Bldg., Philadelphia, Pa.
WHITING, HENRY FREEMAN, '94. 136 E. Curtin St., Bellefonte, Pa.
WHITING, SIDNEY EDWIN, M.E., '98. Pur. Agent, Whiting Paper Co. (1) 249 Oak St., Holyoke, Mass. (2) and (3) Whiting Paper Co., Holyoke, Mass.
WHITING, WYTHE LAWLER, '07, Mobile, Ala.
WHITNEY, HOWARD VROOMAN, '09. Salesman Gen. Elect. Co., 410 Third Ave., Minneapolis, Minn. 4540 Vincent Ave.
WHITNEY, MARK LADD, '97. Red Creek, N. Y.
WHITNEY, WALTER DUNCAN, M.E., '02. Supt. Electric Construction. (1) 2527 Washburn Ave. S., Minneapolis, Minn. (2) and (3) Twin City Lines. Minneapolis, Minn. A. I. E. E.
WHITTEMORE, ALLAN PENDLETON, M.E., '96. 223 Market St., Webster Groves, Mo.
WHITTEMORE, AUDENRIED, M.E., '03. Vice-Pres., Gen Roofing Mfg. Co. (1) 337 N. Euclid Ave., St. Louis, Mo. (2) and (3) 2076–208 South LaSalle St., Chicago, Ill.
WHITTEMORE, CHARLES FRANCIS, M.E., '92. W. Suffield, Conn.
WHITTEMORE, JOHN RAOUL, M.M.E., '93. Real Estate. (1) R. F. D. No. 1, Santa Barbara, Cal. (2) and (3) Howard-Canfield Bldg., Santa Barbara, Cal.
WHITTLESEY, GRANVILLE EGBERT, M.E., '09. 242 Appleton St., Pittsfield, Mass.
WHITTLESEY, WM. A., M.E., '04. Supt. Pittsfield Elec. Co. (1) 1 Crofett St., Pittsfield, Mass. (2) and (3) Pittsfield Elec. Co., Pittsfield, Mass. A. I. E. E., N. E. L. A.
WHITTY, JAMES JOSEPH, M.E., '11. (1) 565 West 148 St., New Yok City. (2) and (3) N. Y. Edison Co., New York, N. Y.
WHYTE, FREDERIC METHVIN, M.E., '89. 14 Benedict Ave., Tarrytown, N. Y.
WHYTE, JESSE STEWART, M.E., '13. Dir. and Sec. (1) 468 South St., Kenosha, Wis. (2) and (3) Macomber & Whyte Rope Co., Kenosha, Wis.
WHYTE, ROBERT BURNS, M.E., '13. 118 Paine St., Worcester, Mass.
WICK, LEMUEL THORN, M.E., '12. Carnegie Steel Co., Youngstown, O.
WIDMER, ARTHUR JACOB, '04. Consulting Engineer. (1) 344 Gray Ave., Webster Grove, Mo. (2) and (3) 941 Century Bldg., St. Louis, Mo.
WIECHARDT, AUGUST JULIUS, M.M.E., '91. University of Florida, Gainesville, Fla.
WIECHERS, MANOLO M., M.E., '16. Howard Ave., Grymes Hill, Staten Island, N. Y.
WIEDERHOLD, EDWARD JOHN, '06. Schenectady, N. Y.
WIELAND, ALBERT EDGAR, M.E., '00. Wenatchee, Wash.
WIEN, PAUL A., M.E., '06. (1) Elec. Engr. North Packing & Provision Co., 128 Bartlett Ave., Waverly, Mass. (2) and (3) Somerville, Mass.
WIESER, GEORGE FERGUS, M.E., '10. Columbia University, New York, N. Y.
WISENER, M. W., M.E., '16. 12 Hart St., Rochester, N. Y. A. I. E. E.
WIGGIN, PHILLIP COLLINS, '11. 234 Herkimer St., Hamilton, Ont., Canada.
WIGGINS, RALPH WILLIAM, M.E., '11. Haskell, N. J.
WIGGLESWORTH, ALBERT WESLEY, M.E., '93. (1) 426 Central Ave., Wilmette, Ill. (2) and (3) Treas. Hill Clarke & Co., Pres. Chicago Machine Tool Co., 125 North Canal St., Chicago, Ill.
WIGHT, FRANK JOHN, M.E., '12. Supt. Southern Utah Power Co. (1) No. 6 Lester Apt., Salt Lake City, Utah. (2) and (3) Box 302, Richfield, Utah.
WIGHT, HARRY COLLINS, M.E., '09. Gen'l Supt., Dayton Water Works. (1) 132 E. Monument Ave., Dayton, O. (2) and (3) Columbia Bldg., Dayton, Ohio. American Water Wks. Assn., Dayton Engrs. Club.
WIGHT, SIDNEY BUCKMINSTER, M.E., '12. Care International Eng. and Trad. Co., Bolshaia, Koninshennaya 129, Petrograd, Russia.
WIGHTMAN, ROLAND J., M.E., '16. N. Y. Telephone Co., 53 Elysian Ave., Nyack, N. Y. A. I. E. E.
WIGLEY, WILLIAM ROY, M.M.E., '15. 33 Stowe St., Ingram, Pa.
WILBUR, J. RALPH, M.E., '97. 800 Postal Tel. Bldg., Chicago, Ill.
WILCOX, ASEL FOSTER, '91. 641 N. Kenilworth Ave., Oak Park, Ill.
WILCOX, PERLEY SMITH, M.E., '97. 84 Beverly St., Rochester, N. Y.
WILCOX, WALLACE JAY, B.M.E., '78. (1) 817 W. 28 St., Los Angeles, Cal. (2) and (3) Las Vegas & Tonapah R. R., Los Vegas, Nev.
WILDBERG, RICHARD MARCUS, '15. 1041 Evans St., Cincinnati, O.
WILDE, HERBERT RUSSELL, '05. Electrical Engineer. (1) Dobbs Ferry, N. Y. (2) and (3) Care of Fearon, Daniel & Co., Inc., Harbin, Manchuria
WILDER, EDWARD L., M.E., '02. Asst. Mgr., Ind. Dept., Rochester R. R. & Lt. Co. (1) 105 Belmont St., Rochester, N. Y. (2) and (3) 34 Clinton Ave. N., Rochester, N. Y. Amer. Soc. Elec. Engr., Nat. Dis. Heating Assn., Nat. Elec. Lt. Assn., Am. Soc. Lt. & Vent. Soc.
WILDER, ERSKINE PHELPS, M.E., '05. 1038 Crosby St., Chicago, Ill.
WILDER, EDWARD T., M.E., '06. Sec. of Wilder & Co. (1) Church St., Elmhurst, Ill. (2) and (3) 226 W. Lake St., Chicago, Ill.
WILE, JULIUS ISAAC, M.E., '97. N. Y. State Rep. for the Permutit Co. (1) 37 Calument St., Rochester, N. Y. (2) and (3) 30 E. 42d St., New York City.
WILEY, CLARENCE FAIRFAX, M.E., '07. Coml. Natl. Bank Bldg., Chicago, Ill.
WILEY, FRED HAROLD, M.E., '15. (1) 2510 E. 5th St., Long Beach, Cal. (2) and (3) Care of Colorado Power Co., Dillon, Col.
WILEY, H. W., M.E., '16. Care of Aluminum Castings Co., Cleveland, O.
WILHELM, EDWARD ADAM, M.E., '90. (1) 612 Central Park Pl., St. Paul, Minn. (2) and (3) Care of Amer. Hoist & Derrick Co., St. Paul, Minn.
WILKE, ERWIN LOUIS, M.R., '12. 86 Norwood Ave., Buffalo, N. Y.
WILKE, WILLIAM LEONARD, M.E., '09. 28 Detroit St., Hammond, Ind.
WILKIN, THOMAS JOHN, '94. Garden Grove, Ia.
WILKINS, ROBERT MORRIS, M.E., '98. Address not known.
WILKINSON, CHARLES THOMAS, '96. Brockville, Ont., Canada.
WILKINSON, JOHN, M.E., '89. Vice-Pres. and Chief Chemist. (1) 1065 James St., Syracuse, N. Y. (2) H. H. Franklin Mfg. Co., Syracuse, N. Y. (3) 1065 James St., Syracuse, N. Y. A. S. M. E., S. A. E.
WILL, PHILIP, M.E., '00. Vice-Pres. and Sales Manager. (1) 7 Highland Heights, R. F. D. No. 2, Rochester, N. Y. (2) and (3) Care Sill Stove Works, Rochester, N. Y.
WILL, WALTER, '10. 25 Union St., Boston, Mass.
WILLETTS, RAY DOUGLAS, M.E., '06. Address not known.
WILLEY, GUY CARLTON, '11. Orchard Park, N. Y.
WILLIAMS, ALAN GILLESPIE, M.E., '03. 6941 Prospect St., Ben Avon, Pittsburgh, Pa.
WILLIAMS, ALBERT BLAKE, M.E., '06. 855 Carroll St., Brooklyn, N. Y.
WILLIAMS, ALPHEUS FULLER, '97. De Beers Diamond Mines, Kimberley, S. Africa.
WILLIAMS, ARTHUR SHALER, M.E., '04. La Delicia Guayabob, Havana Prov., Cuba.
WILLIAMS, CHARLES FRANCIS, M.E., '17. Lieut. U. S. Corps of Engineers, Washington, D. C.
WILLIAMS, CHARLES LAURANCE, M.E, '05. The Defenses of Manila Bay. Manila, P. I.
WILLIAMS, DONALD DAVOL, '06. 5 Park St., Boston, Mass.
WILLIAMS, EDWARD EUGENE, '91. 385 N. 54 St., Birmingham, Ala.
WILLIAMS, ELEAZER DEMING, '08. 43 Henry St., Pittsfield, Mass.
WILLIAMS, FRANK DAVOL, M.E., '03. 401 Clinton Ave., Brooklyn, N. Y.
WILLIAMS, HARTWELL NEWTON, M.E., '12. Gen. Elec. Co., Schenectady, N. Y.
WILLIAMS, HERBERT HOWARD, '94. Lake Shore Eng. Wks., Marquette, Mich.
WILLIAMS, HOWARD EDWARD, M.E., '95. Chief Draftsman Calumet & Hecla Mining Co. (2) Calumet & Hecla Co., Calumet, Mich. (1) and (3) 1144 Calumet Ave., Calumet, Mich. A. S. M. E., A. M. E.
WILLIAMS, J. D., M.E., '13. Excelsior Shoe Co., Portsmouth, Ohio.
WILLIAMS, LAWRENCE BRUMLEY, '14. (1) 137 Garfield Place. (2) and (3) 855 Carroll St., Brooklyn, N. Y.
WILLIAMS, LEE, M.E., '03. Deer Lodge, Mont.
WILLIAMS, OTIS LINCOLN, M.E., '88. 37 Wall St., New York, N. Y.
WILLIAMS, PAUL, M.E., '14. 115 Valentine Place, Ithaca, N. Y.
WILLIAMS, PAUL ALFRED, M.E., '17. 14 Gaylord Ave., Plymouth, Pa.
WILLIAMS, ROSWELL CARTER, JR., M.E., '92. 1719 Chestnut St., Philadelphia, Pa.
WILLIAMS, SAMUEL, M.E., '10. 177 13 St., Salt Lake City, Utah.
WILLIAMS, SCOTT, '94. Advertising Man. and Comm. Artist. (1) 810 W. 4th St., Sterling, Ill. (2) and (3) Room 23, Academy of Music, Sterling, Ill.
WILLIAMSON, GEORGE MORRISON, M.E., '14. (1) 543 Madison St., Brooklyn, N. Y. (2) and (3) Interboro Rapid Transit Co., New York City.
WILLIAMSON, H. HARRY, M.E., '11. Supt. Porcupine Boiler Co. (2) and (3) 730 Warden Ave., Bridgeport, Conn. (1) 688 Park Ave., Bridgeport, Conn.
WILLIAMSON, JOHN KENNEDTY, M.E., '06. (1) 1893 Park Ave., Bridgeport, Conn. (2) and (3) Pres. Porcupine Boiler Co., 730 Wordin Ave.
WILLIAMSON, PHILIP HEARN, '10. Gov't Service, Manila, P. I.
WILLIAMSON, ROBERT, M.E., '93. Engr. Charge A. C. Design. (1) 3006 State St., Milwaukee, Wis. (2) and (3) Allis Chalmers Mfg. Co., Milwaukee, Wis. A. I. E. E.
WILLIE, HENRY VALENTINE, M.E., '92. Asst. Gen. Supt. Baldwin Locomotive Wks. Consulting Metallurgist for Remington Arms and Eddyston Ammunitions Corp. 743 Corinthian Ave., Philadelphia, Pa.
WILLIS, RALPH SANDERSON, M.E., '07. Mfg. Pearl Buttons, Muscatine, Iowa.
WILLIS, WILLIAM, M.E., '98. Woolen Merchant. (2) and (3) 156 Fifth Ave., New York City. (1) 121 Bowne Ave., Flushing, N. Y.
WILLSON, HERBERT MCADAM, M.E., '91. Merchant. (1) 471 E. State St., Sharon, Pa. (2) and (3) Merchant, Sharon Pa.
WILLSON, HIRAM EVERETT, '05. Murphysboro, Ill.
WILSON, ALEXANDER, M.E., '10. 108 W. Baltimore Ave., Lansdowne, Pa.
WILSON, CHESTER PAULTON, M.E., '92. (1) 127 Jefferson St., Scranton, Pa. (2) and (3) 508 Board of Trade, Indianapolis, Ind.
WILSON, EDWARD PERRY, M.E., '11. 555 Linebarger St., Milwaukee, Wis.
WILSON, EMMET CHEATHAM, M.E., '11. Designing Draftsman. (1) 232 S. 6th Ave., Bethlehem, Pa. (2) and (3) Bethlehem Steel Co (Subsidiaries), So. Bethlehem, Pa.
WILSON, FRANK BOYDEN, '11. Address not known.
WILSON, GEORGE ADAMS, '02. S. Paris, Me.

WILSON, GRISWOLD, M.E., '05. (1) 1822 E. 9th St., Cleveland, O. (2) and (3) 1551 Columbus Rd., Cleveland, O.
WILSON, JAMES HENRY, M.E., '04. 7 McAllen St., Amsterdam, N. Y.
WILSON, JAMES ROBERT, '95. N. Mex. Power Co., Santa Rosalia, Chihuahua, Mex.
WILSON, JOHN CROSIER, M.E., '06. Mgr. Thomas Meter Dept. (2) and (3) Cutler Hammer Mfg. Co., Milwaukee, Wis. (1) 538 Stowell Ave., Milwaukee, Wis. Milwaukee Eng. Soc., Am. Gas Inst., Nat. Gas Assn. of Amer.
WILSON, JOSEPH SHIELDS, M.E, '09. 404 S. Clayton St., Wilmington, Del.
WILSON, LEROY ALONZO, M.M.E., '14. 1st Asst. Eng. Exp. Station, Univ. Ill. (2) and (3) Mechanical Lab., Urbana, Ill. (1) 1017 W. Ill. St., Urbana, Ill Sigma Xi.
WILSON, LEROY MERLE, M.E., '94. Nyack, N. Y.
WILSON, LOUIS THOMPSON, '02. Weston Shirt Co., 166 N. State St., Chicago, Ill.
WILSON, OSCAR RAYMOND, M.E., '95. 1825 Sampson Rd., Cleveland, O.
WILSON, ROBERT, M.E., '07. 176 Lincoln Rd., Brooklyn, N. Y.
WILSON, ROBERT MCCRAE, M.E., '96. 47 Park St., Montclair, N. J.
WILSON, STEWART COLLINS, M.E., '17. 630 North Meridian St., Indianapolis, Ind.
WILSON, VICTOR TYSON, M.E., '02. Retired from teaching. East Lansing, Mich. Hon. member Tau Beta Pi., So. Pro. of Eng. Educa.
WILBUR, M., M.M.E., '04. Address not known.
WILTSE, HERBERT ALPHONSON, M.E., '00. Address not known.
WINEBURGH, CHARLES, M.E., '04. 223 Houston St., New York, N. Y.
WING, RAYMOND NOBLE, M.E., '11. Mech. Eng. Aeroplane Design, Curtis Areoplane Co. (2) Curtis Areoplane Co., Churchill, Buffalo, N. Y. (1) and (3) 100 Robie Ave., Buffalo, N. Y.
WING, STEPHEN REMINGTON, M.E., '10. Prof. of Mechanical and Electrical Engineering. (1) (2) and (3) Pennsylvania College, Gettysburg, Pa. Sigma Xi, A. S. M. E.
WING, WALTER STERLING, M.E., '07. 522 Frick Bldg., Pittsburgh, Pa.
WINGO, CHARLES E., JR., M.E., '03. Gen'l Contractor. 902 Park Ave., Richmond, Va.
WINSLOW, CLARENCE GILES, M.E., '15. Churchville, N. Y.
WINSLOW, JOHN, M.E., '11. Navy Yard, Boston, Mass.
WINSTON, WILLIAM OVERTON, JR., M.E., '11. Superintendent, general construction. 801 Globe Bldg., Minneapolis, Minn. A. I. E. E., A. S. A. S.
WINSHIP, W. ROSS, M.E., '11. 125 Hamilton St., Penn Yan, N. Y.
WIPPERMAN, FREDERIC BAZINE, M.E., '13. Traveling Engineer, Ohio Injector Co. (2) and (3) 1437 Monadnock Blk., Chicago, Ill. (1) Logansport, Indiana.
WISE, FRANK LOUNSBURY, M.E., '08. 236 W. 101 St., New York, N. Y.
WISE, HAROLD JACOB, M.E., '06. 1970 S. LaSalle St., Chicago, Ill.
WISNER, HENRY GABRIEL, JR M.E., '11. Hobart Ave., Summit, N. J.
WISNER, JOHN HORNER, JR., M.E., '03. Summit, N. J.
WHITBECK, BENJ. FRANKLIN, M.E., '07. Appraiser Special Franchise, Tax Dept. (2) State Tax Dept., Albany, N. Y. (1) and (3) R. F. D. No. 1, Albany, N. Y.
WITHERBEE, JOHN G., '90. Port Henry, N. Y.
WOHL, NATHAN EDGAR, '95. Address not known.
WOLCOTT, KENNETH OLIVER, M.E., '07. 40 Austin St., Rochester, N. Y.
WOLCOTT, WILLIAM BRISTOL, '11. 65 South St., Great Barrington, Mass.
WOLFE, EUGENE LEWIS, M.E., '14. 1931 St. Paul St., Baltimore, Md.
WOLFF, WALTER WILLIAM, M.E., '12 Salesman. (1) 98 Henry St., Brooklyn, N. Y. (2) and (3) Loring Lane Co., 41 Harrison St., New York City.
WOLLE, RICHARD HARTLEY, '13. 344 Tioga St., Johnstown, Pa.
WOLHEIM, LOUIS ROBERT, M.E., '06. Address not known.
WONDERLY, GEORGE ARTHUR, M.E., '08. Camp Hill, Pa.
WOOD, AUGUSTUS, M.E., '91. General Mgr., The Niles Tool Wks. (2) Niles Tool Wks., 609 N. 3d St., Hamilton, O. (1) and (3) 306 South Ave., Hamilton, O. A. S. M. E.
WOOD, ALFRED THOMAS, M.E., '02. Address not known.
WOOD, CHARLES BRYANT DRAKE, '09. Care of The Pressed Steel Co., Wilkes-Barre, Pa.
WOOD, CHARLES MONTGOMERY, '07. 346 Market St., Chambersburg, Pa.
WOOD, CHARLES PARKINSON, '04, M.E. 17 Battery Pl., New York City.
WOOD, EDGAR HARPER, M.E., '92, M.M.E., '93. Prof. Mechanics of Engrg. (2) Sibley College, C. U., Ithaca, N. Y. (1) and (3) 406 W. Mill St., Ithaca, N. Y. Sigma Xi, S. P. E. E.
WOOD, EDWARD CAREY, '10. Address not known.
WOOD, EDWARD RANDOLPH, '97. University Club, Philadelphia, Pa.
WOOD, FRANK ELLIOTT, '15. 18 W. Pierrepont Ave., Rutherford, N. J.
WOOD, FRANK TRAVERS, M.E., '06. (1) 602 W. Franklin St., Richmond, Va. (2) and (3) Care of Travers Wood Co., 318 Amer. Nat. Bk. Bldg., Richmond, Va.
WOOD, F. W., 1083 Hawthorne Ave., Portland, Ore.
WOOD, GEORGE GREEN, '94. Red Creek, N. Y.
WOOD, GEORGE WHITNEY, '94. Address not known.
WOOD, HARRISON HASKELL, M.E., '92. 3146 Avalon St., Pittsburgh, Pa.
WOOD, HENRY HALE, M.E., '12. 1521 Charleston Ave., Mattoon, Ill.
WOOD, HENRY MILLARD, M.E., '04. Office Mgr., Machine Tools, Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. A. S. M. E., Engineers Club of Cincinnati.
WOOD, HORATIO NELSON, M.E., '92, M.M.E., '93. U. S. S. Algonquin, San Juan, P. R.
WOOD, JOHN JR., '06. Mahartonga St., Pottsville, Pa.
WOOD, JOHN BARTHOLOMEW, M.E., '13. 1036 Walnut St., Newton Highlands, Mass.
WOOD, OLIVER ADELBERT, M.E., '13. 43 Exchange Place, New York, N. Y.
WOOD, PEIRCE MEAD, M.E., '13. Steel salesman. (1) 16 Elmwood Ave., Detroit, Mich. (2) and (3) 1156 Penobscot Bldg., Detroit, Mich.
WOOD, PHILLIP, M.E., '15. (2) and (3) Care of Gifford Wood Co., Hudson, N. Y. (1) 2 Willard Place, Hudson, N. Y.
WOOD, STANLEY VICTOR, '10. 334 S. Franklin St., Wilkes-Barre, Pa.
WOOD, SYDNEY LUNT, M.E., '92, M.M.E., '93. 348 W. 23 St., New York, N. Y.
WOOD, WALTER DOUGAN, M.E., '09. Fuller Engr. Co., Allentown, Pa.
WOOD, WALTER WALLACE, '96. Chippewa Bay, N. Y.
WOOD, WILLIAM MAXWELL, M.E., '08. Pac. Lt. & Pow. Co., Lewiston, Ida.
WOODARD, WILLIAM EDWARD, M.E., '06. 18 Stratford Rd., Schenectady, N. Y.
WOODBRIDGE, HOWARD COOK, M.E., '97. 248 Rugby Ave., Rochester, N. Y.
WOODBRIDGE, JOHN REED, M.E., '95. Mgr. Auto Theft Signal Sales Co. (1) 1647 W. 11th St., Los Angeles, Cal. (2) and (3) 1000 S. Hill St., Los Angeles, Cal.
WOODFORD, FRED, M.E., '09. 129 E. Mill St., Ithaca, N. Y.
WOODHULL, GILBERT BERGEN, M.E., '00. Lumber business. (1) and (2) Reading, Pa. (3) P. O. Box 462, Reading, Pa.
WOODLAND, LEROY, M.E., '06. Bond business. (1) Kenilworth, Ill. (2) and (3) 105 S. LaSalle St., Chicago, Ill.
WOODLE, GEORGE BRADLEY, '15. Ass't to President. (2) and (3) C. C. Bradley & Son, 432 N. Franklin St., Syracuse, N. Y. (1) 109½ Shonnard St., Syracuse, N. Y. Technology Club of Syracuse.
WOODROW, WILLIAM TILLMAN, M.E., '15. Salesman. (1) 14 Verona Apts., Cincinnati, O. (2) and (3) Aluminum Castings Co., Cleveland, Ohio.
WOODRUFF, WILLIAM WARREN, M.E., '11. (1) 103 Linwood Ave., Ardmore, Pa. (2) and (3) E. I. du Pont Powder Co., City Point, Va.
WOODS, ARTHUR PAGE, M.E., '10. Maple Ave., Turtle Creek, Pa.
WOODS, DAVID SHELLEY, M.E., '04. 930 S. St. Bernard St., Philadeplhia, Pa.
WOODS, JOHN ANDERSON, '06. 342 W. 56, New York City.
WOODS, ROBERT HARRIS, '13. 52 Vick Park B., Rochester, N. Y.
WOODS, SAMUEL HAMILTON, M.E., '06. Asst. Engr. General Vehicle Co. (1) 39 Academy St., Long Island City. (2) and (3) General Vehicle Co., Long Island City, N. Y. S. A. E., A. S. M. E.
WOODWARD, ARTHUR COY, A.B., M.E., '17. 221 Cornell St., Ithaca, N. Y.
WOODWARD, ARTHUR HERBERT, M.E., '92. Pres. International Register Co. (2) and (3) 15 S. Throop St., Chicago, Ill. (1) Altadena, Cal. A. S. M. E.
WOODWARD, GEORGE WILLIAM, '09 M.E. Manager Albany office Rockwood Sprinkler Co. (1) 422 S. Manning Boulevard, Albany, N. Y. (2) and (3) 322 Arkay Bldg., Albany, N. Y. S. A. E.
WOODWORTH, GEO. KEEN, M.E., '96. Lawyer. (2) and (3) 60 Congress St., Boston, Mass. (1) 24 Strathmore Rd., Brookline, Mass.
WOODWORTH, OLIN FITCH, M.E., '08. Asst. Chief of Experiments, designing Agr. Implements. (2) and (3) Bateman Mfg. Co., Grenloch, N. J. (1) Grenloch, N. J. F. & A. M.
WOODWORTH, PHILIP BELL, M.E., '90. (2) Dean and Prof. of Eng., Lewis Inst., Chicago. (1) and (3) 5809 Race Ave., Chicago, Ill. A. I. E. E., West. Soc. of Eng., Electric Club of Chicago, Tau Beta Phi.
WOOLDRIDGE, ROBERT DORSEY, '96. Morristown, N. J.
WOOLF, WILLIAM BUXTON, '05. Keyser, W. Va.
WOOTTON, HENRY TISSINGTON, '10. Box 93, Boonton, N. J.
WORDENP, HAROLD EVERETT, M.E., '08. 4 Washington St., Potsdam, N. Y.
WORN, G. AUSTIN, 217 West Ave., Ithaca, N. Y.
WORRALL, CLAYTON SMITH, M.E., '05. 109 E. 6 St., Media, Pa.
WORRELL, RUFUS ISAAC, '11. Y. M. C. A., Providence, R. I.
WORTHLEY, IRVING TUPPER, M.E., '06. 5338 Angora Terrace, Philadelphia, Pa.
WORTMAN, GEORGE AUGUSTUS, M.E., '08. 84 State St., Boston, Mass.
WORTMANN, OTTO, '06. (1) 3 Herr St., Wilkinsburg, Pa. (2) and (3) 310 E. 91st St., New York, N. Y.
WOSIKA, LEON RUDOLPH, '05. 419 Electric Bldg., Cleveland, O.
WRAY, ALFRED BUSSELL, M.E., '05. 111 Orchard St., Ithaca, N. Y.
WRAY, BURT GILLENDER, M.E., '95. Box 67, New York, N. Y.
WRENN, HENRY BRADLEY PLANT, '96. N. Y. Central Ry., New York, N. Y.
WRIGHT, ALBERT LAWRASON. Address not known.
WRIGHT, ABNER MILES, M.E., '17. 946 Forest Ave., Evanston, Ill.
WRIGHT, DOUGLAS BERRY, M.E., '15. 1075 Peachtree St., Atlanta, Ga.
WRIGHT, EDWARD ALBIN, M.E., '08. 951 Ellicott Sq. Bldg., Buffalo, N. Y.
WRIGHT, FREDERICK MILLER, M.E., '15. Granada Hotel, Sutter and Hyde Sts., San Francisco, Cal.
WRIGHT, FREDERICK WILLIAM, M.E., '17. Forest Glen, Md.
WRIGHT, IVAN HORTON, '09. 31 Kingsboro St., Gloversville, N. Y.
WRIGHT, JAMES CHESTER, M.E., '09. Telephone Engr., West. Elec. Co. (2) and (3) 463 West St., New York, N. Y. (1) Murray Hill, N. J. A. I. E. E.
WRIGHT, JOHN MARVIN, M.E., '13. Washington Barracks, Washington, D. C.
WRIGHT, RICHARD AVERY, M.E., '05. 446 Ocean Ave., Buffalo, N. Y.
WRIGHT, RICHARD HORATIO, M.E., '09. (1) The Verne, 7913 Carnegie Ave., Cleveland, O. (2) and (3) 1457 E. 118 St., Cleveland, O.
WRIGHT, STANLEY, M.E., '12. Asst. to Chief Engineer. (1) 3548a Pestotozzi St., St. Louis, Mo. (1) 21 Hawthorne St., Brooklyn, N. Y. (2) and (3) Burch-Sulzer Bros., Diesel Engine Co., St. Louis, Mo. A. S. M. E., Tau Beta Pi.
WRIGHT, WILFRED LA SEELES, M.E., '00. 50 Church St., New York City.
WRIGHT, WILLIAM SNOWDEN, M.E., '12. (1) Hotel Altamona, Baltimore, Md. (2) and (3) 1200 Madison Ave., Baltimore, Md.
WRIGHT, WILLIAM TITUS, '08. 69 Lefferts Pl., Brooklyn, N. Y.
WROTH, WILLIAM BURKE, M.E., '13. 43 Exchange Pl., New York City.
WU, KUEI LING, M.E., '05. Peking Mukden Ry., Tientsin, China.
WURST, GEORGE WASHINGTON, M.E., '02. 190 Lakewood St., Buffalo, N. Y.
WURTS, THOMAS CHILDS, M.E., '13. 1164 Strady Ave., Pittsburgh, Pa.
WYCKOFF, ARCALOUS WELLING, M.E., '96. 420 N. Craig St., Pittsburgh, Pa.
WYLIE, ARTHUR GOVE, M.E., '05. 46 Taylor St., Springfield, Mass.
WYLIE, CLARENCE RAYMOND, '05. Asst. Prof. Elec. Engr. (1) and (3) 219 Woolper Ave., Cincinnati, O. (2) Univ. of Cincinnati, Cincinnati, O. A. A. A. S., Mem. Council Nat. Econ. League.
WYLIE, WILLIAM HARRY, JR., '11. 359 Park Ave., Rock Hill, S. C.
WYMAN, H., M.E., '16. 58 West St., Worcester, Mass.
WYNNE, JOHN H., '98. Mgr. Montreal Locomotive Wks., Ltd., also charge of Light Locomotive Dept., Amer. Locomotive Co., 30 Church St., New York City. (2) Dominion Express Bldg., Montreal, Can. (3) 703 Dominion Express Bldg., Montreal, Can. (1) 4339 Westmount Ave., Westmount, Can. A. S. M. E., Engrs. Club (N. Y.), Engrs. Club (Montreal).

XEREZ-BURGOS, JOSÉ, '10. Conception St., Manila, P. I.

YAHN, CHARLES, '14. Y. M. C. A. (1) Mansfield, O. (2) and (3) Alt. & Taylor Machine Co., Mansfield, O.
YALE, FRED S., M.E., '03. Real Estate. (2) and (3) 110 West 34th St., New York City. (1) 385 Sanford Ave., Flushing, N. Y.
YAMAZAKI, SHIRO, M.E., '02. 2 Chome Ich., Beimach, Azabo, Tokio, Japan.
YANG, CHIEN, M.E., '16. Engr. or Mgr., Care of Mr. P. K. Chn, 51 Bubbling Well Rd., Shanghai, China. Hangchow, China. Science Society of China.
YANG, SHU ZEK, M.E., '15. A. 19 Hong Sheng Fong, Pao Shen Rd., Shanghai, China.
YATES, HARRY DESHIELDS, M.E., '93. Address not known.
YATES, THOMAS JARVIS, M.E., '02. 1003 Boston Bldg., Salt Lake City, Utah.
YATES, WILLIAM HENRY, M.E., '06. Sales Eng. Allis Chalmers Mfg. Co. (2) and (3) Alworth Bldg., Duluth, Minn. (1) 636 E. 3d St., Duluth, Minn. Lake Superior Mining Inst.
YAWGER, EDWIN, M.E., '91. 1064 Gas & Elec. Bldg., Denver, Colo.
YCASIANO-ROXAS, FRANCISCO, M.E., '07. Bur. of Science, Manila, P. I.
YCAZA, OSWALDA A., '94. Panama, S. A.
YEAGER, L. R., M.E., '13. 23 W. Lane Ave., Columbus, Ohio.
YEAGER, WILLIAM HARVEY, '06. Box 65, Forty Fort, Pa.
YEATMAN, WALTER CLARK, M.E., '99. (2) Care of Chicago Nut Co., 617 Jackson Blvd., Chicago, Ill. (1) and (3) 1607 Kenilworth Ave., Chicago, Ill.
YEN, KING LAU, '10. 40 12 St., Canton, China.
YEN, KIA LAK, A.B., '15. American Presbyterian Mission, Hoihow, Hainan, So. China.
YENGER, WILLIAM CORNELIUS, '04. 66 W. 39 St., New York City.
YERKES, CHARLES GREENLUO, '11. 402 N. Grove Ave., Oak Park, Ill.

YERZLEY, WILLIAM ALFRED, M.E., '92. 160 Summit Ave., Newark, N. J.
YOAKUM, FINIS EWING, M.E., '12. Special work, Exec. Dept. S. P. Co., Executive office, S. Pacific Co. (2) Flood Bldg., San Francisco, Cal. (1) and (3) 140 East Ave., Los Angeles, Cal.
YOST, HENRY ADAMS, '10. Waterloo, N. Y.
YOUENS, ALFRED VINCENT, M.E., '03. City Electrician, Palo Alto, Cal. 181 Byron St., Palo Alto, Cal. A. I. E. E.
YOUNG, ANDREW DEWING, M.E., '05. 325 Main St., Owego, N. Y.
YOUNG, CHARLES DUNCANSON, M.E., '02. 1128 15 St., Altoona, Pa.
YOUNG, EZRA LAWRENCE, M.E., '13. Trumansburg, N. Y.
YOUNG, GEORGE ABERDEEN, '13. Treas. Julian Motor Co., Syracuse, N. Y.
YOUNG, GEORGE HARPER, M.E., '00. Ansco Co., 93 Main St., Binghamton, N. Y.
YOUNG, HUGH WALLACE, M.E., '15. 195 3d Ave., Long Island City, N. Y.
YOUNG, JAMES, '05. Middletown, Pa.
YOUNG, JAMES CHARLES, M.E., '94. Ia. Ry. & Lt. Co., Cedar Rapids, Ia.
YOUNG, JOHN MASON, M.E., '02, M.M.E., '04. College of Hawaii, Honolulu, Hawaii.
YOUNG, JOHN PAUL, M.E., '97 (1) Youngstown, O. (2) 704 Dollar Bank Bldg., Youngstown, O. A. S. M. E., Am. Soc. for Testing Materials.
YOUNG, THOMAS SLOAN, JR., M.E., '15. 1155 Riverside Drive, New York City.
YOUNG, WILLIAM SMITH, '90. 66 Liberty St., New York City.
YOUNGLOVE, CHARLES MYRTLE, M.E., '97. Supt. Movers, W. E. & M. Co. (1) Hammondsport, N. Y. (2) and (3) 214 N. 22 St., Philadelphia, Pa.
YOUNGLOVE, DAVID, M.E., '12. (1) 270 Cortland Ave., Syracuse, N. Y. (2) and (3) Asst. to Sales Mgr. The O. M. Edwards, Inc., Syracuse, N. Y.
YUNDT, HARRY SCHULTZE, '09. 705 College Ave., East Liberty, Pa.
ZABRISKIE, HENRY LYLES, M.E., '98. Chief Engr. (2) and (3) Diehl Mfg. Co., Elizabethport, N. J. (1) 36 Stanley Rd., Westfield, N. J. A. I. E. E., S. A. E.
ZABRISKIE, W. HOWARD, M.E., '13. Engineer, Case and Can Mfg. for Exports. (2) Standard Oil Co., 10th St., Long Island City. (1) Glen Cove, L. I. (3) 55 Hanson Place, Brooklyn, N. Y. A. S. M. E.
ZAHM, ALBERT FRANCIS, M.E., '92. Cath. Univ. of Am., Washington, D. C.
ZALDUONDO, JUAN, '95. Lazardo, P. R.
ZEESE, ROBERT ALEXANDER, '03. Address not known.
ZEUER, ROBERT DODGE, '07. 718 Board of Trade Bldg., Indianapolis, Ind.
ZIEGER, KENNETH G., M.E.,'14. 138 Park St., Montclair, N. J. A.S.M.E.
ZIES, FREDERICK, M.E., '02. Athol Terr. Sta. D., Baltimore, Md.
ZIMMERMAN, EARL WILLIAM, M.E, '07. 1502 W. Onondaga St., Syracuse, N. Y.
ZIMMERMAN, HARRY, M.E., '95. 1118 Birchard Ave., Fremont, O.
ZIMMERMAN, EDWARD FORSYTHE. 249 Auburn St., Buffalo, N. Y.
ZIMMERS, FRANK HENDERSON, A.B., '12. 1733 Beechwood Blvd., Pittsburgh, Pa.
ZINK, GEORGE WILLARD, M.E., '12. 1021 Central Ave., Bridgeport, Conn.
ZINK, ROBERT EDWARD, M.E., '11. 1103 Central Ave., Bridgeport, Conn.
ZIPP, PHILLIP HENRY, M.E., '05. 1440 No. Eden St., Baltimore, Md.
ZOCH, FRANK PAUL, '08. 6824 Thomas St., Pittsburgh, Pa.
ZOUCK, GEORGE HAUER, M.E., '11. 314 Yorke St., Hanover. Jr. Member A. S. M. E.
ZUCKERMAN, SAMUEL, '09. 1381 Franklin Ave., New York City.

GEOGRAPHICAL LIST OF FORMER STUDENTS OF SIBLEY COLLEGE

ALABAMA

Anniston. J. B. Chaffe, '12;
Birmingham. G. F. Bason, '16; C. Blake, '05; J. I. Blount, '98; C. W. Cornell, E. F. Enslen, '02; G. C. Estill, '07; R. Pinckhard, '05; A. M. Roberts, '11; W. K. Wells, '12; E. E. Williams, '91.
Dernopolis. H. L. Bachus, '99.
Enfania. A. B. Roberts, '14.
Ensley. C. J. Barr, '93.
Fairfield. J. M. Lutz, '13.
Geiger. C. B. Tarr, '97.
Huntsville. W. M. Wellman, '13.
LaFayette. H. Black, '06.
Montgomery. J. M. Baldwin, '09; R. M. Henderson, '09.
Mobile. W. J. Hearin, '04; A. W. Rubira, '05; C. W. Stanton, '07; W. L. Whiting, '07.
Mountain Creek. E. R. Tabor, Jr., '08.
Piper. C. Jones, '06.
Sheffield. J. Abbott, '00; E. D. McConnell, '94.
Uniontown. S. L. Harwood, '97.

ARIZONA

Bisbee. H. W. Thorne, '11.
Douglas. C. S. Adams, '04.
Flagstaff. E. Fritz, '08.
Miami. A. H. Bamman, '16.
Phoenix. H. L. Allen, '06; W. C. McArthur, '08.
Tucson. H. W. Arnold, '13; B. A. Snow, '10.

ARKANSAS

Argenta. C. C. Schott, '02.
Eureka Springs. C. F. Kincaid.
Fayetteville. M. M. Martin, '02.
Little Rock. F. I. Brown, '03; J. H. Cochran, '15; S. A. Cochran, '09; M. A. Cohn, '11; J. H. Dodge, '10; J. S. Herring, '80; J. F. Muller, '04; C. E. Rose, '05.
Marianna. J. M. Hewitt, '06.
Monticello. E. R. Lambert.

CALIFORNIA

Alhambra. H. A. Eckert, '02.
Auburn. W. F. Brye, '12; H. T. Sutcliffe, '16.
Berkeley. G. Brill, '95; L. R. Chilcote, '16; C. N. Cory, '91; J. N. Le Conte, '92; D. H. Parce, '09, O. R. Marston, '17.
Bishop. D. Van Law, '13.
Bloomington. S. J. Buntington, '75.
Campbell. L. C. Ralston, '96.
Corona. E. H. Gimper, '02.
Coulterville. T. B. McCarthy, '75.
Crockett. L. L. Edmunds, '05.
Death Valley. E. A. Lynn, '12.
El Segunda. R. W. Hanna, '11.
Fullerton. S. Dodge, '13.
Glenn. W. A. Taylor, '94.
Glant. W. D. Craig, '10.
Geyserville. S. G. Hoffman, '10.
Hollywood. C. F. Blakslee, '14.
Huntington Beach. A. B. Rogers, '10.
Long Beach. S. L. Strond, '03; A. C. Voorhees, '13.
Los Angeles. W. H. Anderson, '11; A. C. Balch, '89; H. Banning, Jr., '16; C. W. Black, '05; R. E. Borden, '10; H. A. Bruce, '05; G. B. Carpenter, '06; E. C. Clark, '94; H. H. Clark, '00; C. A. Copeland, '96; J. H. Davidson, '10; C. B. Dodge, '04; W. G. Edmundson, '02; W. B. Holmes, '07; E. H. Howes, '96; C. H. Hatch, '07; R. W. Hiett, '08; O. T. Johnson, '08; S. C. Lines, '98; R. S. Meyler, '16; A. E. Milliken, '94; G. L. Morris, '07; F. R. Mowrer, '94; J. H. Ogle, '00; R. L. Reynolds, '97; F. T. Richards, '97; B. M. Sawyer, '92; C. H. Smith, '14; W. Taylor, '95; W. J. Wilcox, '78; J. R. Woodbridge, '95.
Los Altos. R. W. Lohman, '01.
Los Gatos. R. D. Lamb, '06.
Menlo Park. E. M. Doyle, '96.
Oakland. H. P. Bell, '10; E. G. Chandler, '00; C. E. Hardy, '00; L. B. McBride, '10; E. P. Rain, '77; E. D. van Löben Sels, '06.
Ocean Park. L. E. Judson, '10.
Palo Alto. C. N. Cross, '06; W. R. Eckart, '95; C. E. Haughton, '94; G. H. Marx, '93; E. P. Lesley, '05; H. J. Ryan, '87; H. R. Terwilliger, '97; R. Topp, '07; A. V. Youens, '03.
Pasadena. W. D. Card, '94; H. L. Doolittle, '06; O. H. Ensign, '84; W. W. Everson, '95; C. W. Livermore, '73; J. L. Mothershead, '03; W. H. Nevin, '00; J. N. Nevins, '94; G. F. Otis, '80; H. O. Phillip, '07; W. F. Rath, '05; H. L. Rochrig, '14; E. F. Scattergood, '99; E. Tompkins, '98; L. A. Webb, '04.
Redondo Beach. A. W. Sinclair, '09.
Rivera. C. L. Edmundston, '02.
Riverside. G. E. Wells, '07.
Sacramento. C. Browning, Jr.; W. H. Evans, '06; L. B. Luppen, '07.
San Diego. A. M. Ackerman, '16; F. N. Adler, '10; E. W. Jewell, '93; G. C. Sumner, '07.
San Francisco. I. Baum, '03; B. B. Beckett, '04; R N. Bishop, '00; J. F. Borden, '04; G. de Bretteville, '10; C. B. Cornell, '96; C. H. Delaney, '02; E. H. Eager, '13; E. A. Emerson, '10; C. W. Evans, '05; L. F. Fuller, '12; S. Hazlewood, '03; H. B. Henderson, '94; W. D. Kendrick, '07; P. J. Kent, '14; R. Knibloe, '10; M. Kraemer, '07; G. S. Lacy, '04; A. Mc Donald, '05; A. Morhs, '13; J. D. Newman, '15; T. H. Nichols, '94; B. G. deNormandi, '13; C. M. Oddie; N. E. Otterson, '99; H. E. Paine, '06; F. H. Potter, '13; J. G. Russell, '79; H. H. Scott, '04; I. Scott, '11; L. I. Scott, '99; H. B. Squires, '96; H. Stephenson, '07; H. H. Tracey, '93; R. Van Norden, '96; W. G. Vincent, '04; F. M. Wright, '15; F. E. Yoakum, '12.
Santa Barbara. J. R. Whittemore, '95.
Silsbee. D. G. Kramar, '15.
Stockton. E. O. Billwiller, '08.
Ventura. F. G. Candee, '96.
Walnut Creek. R. Spencer, '13.
Whitlock. T. M. Bains, '99.
Yucaipa. P. B. Hasbrouck, '96.

COLORADO

Black Hawk. F. N. Rogers, '90.
Boulder. J. H. Sherwin, '13.
Colorado Springs. M. L. Berry, '02; A. W. Buchanan, '87; F. A. Johnson, '96; L. W. Lennox, '08.
De Beque. R. T. Clapp, '10.
Denver. H. J. Adams, '10; W. R. Culbertson, '14; C. Hartley, '94; W. P. Holman, '05; W. E. Irish, '12; A. L. Jones, '04; F. A. Lockwood, '01; H. H. McPherson, '03; F. J. Matty, '09; B. E. Nock, '12; R. N. Robertson, '05; A. H. Seep, '95; T. H. Smith, '89; A. H. Stack, '14; P. J. Taylor, '11; W. L. Upton, '86; H. R. Weber, '95; E. Yawger, '91.
Dillon. F. H. Wiley, '15.
Durango. R. V. Ritter, '03.
Fort Collins. L. D. Crain, '02.
Greeley. H. A. Lang, '15.
Ouray. A. M. Roberts, '09.
Penrose. W. S. McCormick, '17.
Pueblo. F. S. Adams, '05; W. J. Lester, '96; G. T. Pollard, '03.

CONNECTICUT

Beacon Falls. M. L. Warner, '06.
Bethel. H. J. Read, '05.
Bridgeport. W. R. Annin, '06; F. M. Avery, '16; R. Bartholomew, '15; C. G. Barrett, '11; W. Brown, '98; L. F. Burnham, '14; A. H. Canfield, '99; J. J. Chew, 2d, '15; H. E. Cobb, '15; B. S. Coe, '06; G. S. Coffin, Jr., '12; C. B. Cronan, '15; A. I. Davis, '15; S. P. Davis, '12; E. M. Fernald, '15; J. O. Green, '15; C. T. Hewitt, '08; H. F. Hodgkins, '15; W. E. Hogan, '06; W. Kent, '15; A. W. Limont, '15; S. D. Locke, '93; C. D. Maxfield, '12; S. H. Patterson, '02; P. H. Powell, '95; D. G. Roos, '11; K. B. Warner, '16; W. R. Webster, jr., '90; H. H. Williamson, '11; J. K. Williamson, '06; G. W. Zink, '12; R. E. Zink, '11; W. A. Coulter, '17.
Bristol. W. S. Ingraham, '79.
Clintonville. I. A. Boyce, '05.
Collinsville. R. C. Jones, '17.
Danbury. F. W. Hoyt, '14; T. C. Millard, '07; R. K. Reynolds, '17.
Derby. W. A. Gordon, '96.
East Hampton. A. B. Starr, '07.
Fairfield. H. A. Sturges, '08.
Gales Ferry. J. P. Satterlee, '00.
Glenbrook. L. A. Sayre, '13.
Glastonbury. L. W. Goodrich, '99.
Groton. A. T. Avery, '14; T. S. Bailey, '96.
Hartford. M. Acker, '13; G. T. Brown, '06; L. H. Brown, '98; W. H. Chapman, '13; L. M. Church, '13; P. J. Darlington, '91; H. E. Heath, '88; W. S. Jacobs, '97; T. S. McEwen, '11; H. F. Penney, '10; A. D. Stoddard, '16; H. A. Ward, '98.
Milford. D. J. Greene, '95; W. F. Kelly, '99.
Naugatuck. R. C. Warner, '98.
New Britain. R. C. Gemond, '09; B. A. Porter, '13.
New Canaan. F. C. Slade, '97; H. F. Scoville, '06.
New Haven. B. F. Bardo, '13; H. M. Beirne, '03; H. L. Cowing, '00; F. Cutts, '97; M. J. Hamant, '12; R. A. Ives, '02; E. D. Kilburn, '05; H. E. Longwell, '83; W. A. Maynard, '96; F. H. Nicholson, '12; F. B. Standish, '99; H. O. Stanton, '10; H. T. Van Wagenen, '03; W. Watson, '93.
New London. E. F. Morgan, '02.
Norwalk. P. S. Morgan, '13; D. H. Gleason, '14; E. Hill, Jr., '99; G. D. Kratz, '12.
Norwich. P. T. Vanderwaart, '09.
Plainville. R. L. Seymour, '13.

Putnam. H. A. Knight, '16.
Southport. R. P. Wakeman, '72.
Stamford. A. H. Emery, '98; C. W. Hubbell, '07; A. W. Keller, '14; M. C. Maxwell, '00; C. W. Nickerson, '06; N. H. Schickel,'09; A.C.Tate,'98.
Storrs. W. D. Hatfield, '15.
Suffield. D. G. Sherwin, '13; C. F. Whittemore, '92.
Torrington. C. T. Guilford, '04.
Wallingford. J. J. Crain, '96.
Waterbury. F. G. Dennison, '15; D. R. Francis, '09; H. G. Jackson, '99; A. R. Mabey, '99; F. Martindall, '14; F. A. Riley, '10; G. R. Rinke, '13; W. E. Rouse, '13; E. S. Sanderson, '94; S. C. Vincent, '05; L. D. West, '07.
West Hartford. F. C. Neilson, '98.

DELAWARE

Edgemoor. J. H. Shaw, '12.
Laurel. B. F. Parker, '98.
Lewes. S. H. Maull, '05.
Newcastle. I. S. K. Reeves, '78.
Newport. A. P. S. Krebs, '03.
Wilmington. E. G. Ackert, '05; W. Betts, '74; J. T. Brown, '06; F. Carnes, '08; W. S. Carpenter, Jr., '10; L. A. Cazenove, '03; J. E. Forgy, '06; C. S. Gladden, '00; W. E. Henderer, '05; E. Moxham, '04; J. F. Passmore, '14; W. H. Riley, '86; D. A. Stoddard, '08; H. L. Seaman, '09; R. L. Stone, '07; C. R. Van Trump, '89; I. Warner, '04; J. S. Wilson, '09; F. G. Tallman, '17.

DISTRICT OF COLUMBIA

Washington. H. J. Allen, '06; G. H. Ashley, '90; W. C. Ballentyne, '12; W. J. Barnes, '15; J. H. Bates, '03; L. L. Beebe, '06; L. Boedeker, '04; W. A. Borden, '12; A. Bostroem, Jr., '06; F. A. Bower, '10; P. R. Buchanan, '10; C. E. Burgoon, '06; W. W. Burns, '06; G. H. Burpee, '83; H. H. Burroughs, '94; C. H. Butman, '11; L. P. Clephane, '92; A. S. Conklin, '95; G. F. Cook, '94; M. S. Cooley, '96; W. Dalton, '90; M. W. Davis, '08; S. J. Dennis, '06; I. P. Disney, '88; H. W. Dix, '11; H. Dulin, '05; W. H. Eagan, '14; F. H. Eastman, '99; C. E. Edwards, '12; W. F. Endress, '13; A. W. Evans, '93; R. F. Fleming, '10; R. S. Gehr, '06; C. M. Green, '93; F. E. Haskell, '06; B. H. Hamilton, '99; F. H. Hayn, '97; H. A. Heine, '07; A. H. Herschel, '90; C. O. Howland, '06; R. W. Hunter, '05; H. H. Jacobs, 10; R. H. Kent, '12; R. S. Lamb, '97; E. D. Lamb, '15; E. Landers, '05; M. D. Lee, '08; W. D. Leetsch, '15; W. F. Legg, '94; F. W. Lewis, '94; L. R. Lohr, '16,; N. B. Mallan, '15; E. G. Mason, '94; C. A. McAllister, '87; W. R. Metz, '97; L. D. Miller, '96; C. B. Merick, '05; A. D. Morehouse, '93; G. T. Morris, '12; C. W. Mortimer, '07; R. Munden, '06; K. H. Nash, '12; W. B. Newton, '98; R. F. Nourse, '95; C. R. Norton, '01; R. E. Phelan, '10; R. B. Putnam, '01; W. B. Rice, '07; E. C. Rossbach, '06; G. J. Ruhlen, '07; H. F. Schoenborn, '95; J. H. Sherman, '11; M. R. Spransy, '15; J. B. Turner, '95; J. D. Vincent, '11; C. D. Westcott, '95; J. M. Wright, '13; A. F. Zahm, '92; J. B. Kalbfus, '17; H. C. Schneider, '17; E. A. Valade, '17; C. F. Williams, '17.
Tacoma Park. G. R. Lehman, '09; W. L. Warfield, '15.

FLORIDA

Bradentown. P. R. Chambers, '12.
Cocoanut Grove. F. L. Church, '92; C. J. Christesen, '14.
Daytona. H. C. Thompson, '06.
Fort Meyers. E. W. Ashmead, '11.
Gainesville. N. J. Wiechardt, '91.
Jacksonville. R. W. Mattox, '95; H. R. Rosebro, '12; L. D. Smoot, '01.
Key West. C. J. Ohend'hal, '07.
Miami. C. G. Hannock.
Orlando. A. W. McKay, '08.
Panama City. R. L. Powers, '07.
Pensacola. G. W. Griffiths, '10, H. A. Holmes, '06.
St. Augustine. C. I. Day, '05.
Winter Haven A. M. Tilden, '11.

GEORGIA

Athens. W. B. Hodgson, '07.
Atlanta. W. A. Bennett, '11; A. N. Bentley, '04; D. H. Braymer, '08; L. S. Collier, '06; J. S. Coon, '77; R. Gregg, '06; E. C. Gruen, '12; A. C. Hastings, Jr., '10; W. S. Hazard, '16; G. Hillyer, '96; A. A. Holmes, '04; M. E. Lopez, '99; H. B. Odell, '02; S. L. Rich, '02; H. A. Weiss, '12; D. B. Wright, '15.
Augusta. P. R. Lamar, '02.
Barnesville. J. H. Smith, '13.
College Park. B. Smith, '15.
Columbus. J. K. Hinde, '90.
Decatur. F. McMaster, '92.
Macon. J. T. Moore, Jr., '10; W. L. Southwell, '05;
Newman. F. B. Cole, '84.
Pelham. J. L. Hand, '11.
Savanah. F. P Ballinger, '04; C. J. Curtiss, '01; T. L. Dunn, '06; H. F. Johnson, '06; F. F. Gaines, '95.
Tunnel Hill. A. W. West, '15.
Waycross. C. M. Bomeisler, '17.

IDAHO

Bliss. W. D. McClellan, '12.
Boise. B. F. Armstrong, '14; H. Pefley, '17.
Gooding. G. A. Biersach, '14.
Hailey. H. T. Picotte, '99.
Lewiston. W. M. Wood, '08.
Nampa. J. T. R. McCorkle, '03.
Pocatello. J. D. Rogers, '09.
Twin Falls. E. V. Berg, '02.
Wallace. E. P. Smith, '00.

ILLINOIS

Alton. F. W. Olin, Jr., '12.
Amboy. W. G. Reynolds, '97.
Anchor. A. D. Stewart, '91.
Aurora. W. E. Barclay, '09; F. E. Royston, '14; L. S. Stephens, '16.
Berwyn. G. W. Struckman, '15.
Blue Island. A. M. Guenther, '97.
Carthage. E. C. Mack, '14.
Canton. L. D. Bass, '11.
Chebanse. M. E. Evans, '11.
Chicago. A. G. Allen, '04; C. D. Allen, '94; H. H. Allport, '14; H. Atwater, '06; H. A. Atwater, '12; B. C. Bachrach, '96; W. A. Backus, '10; W. G. Baird, '08; N. L. Baker, '05; W. H. Baldwin, '89; F. N. Bard, '04; H. Bartholomay, '07; A. C. Bell, '05; E. L. Beifield, '10; B. H. Bendheim, '07; J. E. Bennett, '94; J. A. Benjamin, '08; W. Bentley, '98; S. A. Bingham, '05; F. H. Bird, '11; P. P. Bird, '00; T. N. Bishop, '12; W. H. Bishop, '96; E. J. Blair, '05; E. L. Blakeslee, '04; C. F. Blake, '94; R. H. Bourne, '05; H. S. Bowen, '95; L. C. Bowes, '13; E. C. Boynton, '87; S. D. Boynton, '93; W. R. Boyd, '14; L. R. Bradley, '08; L. F. Brahmer, '08; H. N. Brooks, '88; J. E. Brosseau, '11; C. E. Brown, '98; C. L. Brown, '95; H. S. Budd, '00; C. F. Burke, '11; R. Burnham, '97; E. A. Burrows, '02; F. B. Caldwell, '12; M. S. Canaday, '10; J. C. Campbell, '00; W. H. Carden, '06; C. A. Carpender, '05; A. S. Calkins, '08; P. M. Chamberlain, '90; T. S. Chalmers, '04; W. C. Clancy, '13; C. F. Clark, '16; E. B. Clark, '94; J. O. Clark, '03; L. H. Clark, '14; C. W. F. Coffin, '12; S. W. Cook, '10; W. J. Corboy, '13; C. P. Cox, '08; C. S. Crafts, '16; J. G. Crawford, '01; W. H. Crumb, '95; S. Cunningham, Jr., '15; C. W. Davis, '07; E. S. Davis, '98; E. S. Dawson, '14; H. L. Dawson, '07; A. C. Day, '14; W. A. Day, '86; M. De Angelis, '13; D. M. Dewey, '14; J. P. Dods, '08; E. A. Drake, '99; T. K. Easton, '16; M. B. Edgerton, '03; S. R. Edwards, '03; D. W. Ellyson, '05; C. W. Elmes, '95; C. L. Etheridge, '91; F. G. Fabian, '05; S. W. Farnham, '94; A. C. Field, '91; C. A. Gaensslen, '06; A. W. Gage, '99; W. B. Gilles, '04; W. D. Gillette, '07; J. Goetsch, '04; J. S. Goddard, '14; C. B. Goodspeed, '08; L. E. Gould, '00; J. D. Grant, '09; J. A. Gray, '16; J. B. Green, '09; W. S. Green, '16; E. M. Hagar, '94; E. C. Hasselfeldt, '97; C. D. Hart, '06; C. G. Hawley, '90; H. Hechheimer, '06; R. J. Healy, '94; L. A. Henderson, '11; C. M. Henrottin, '97; H. A. Hess, '02; J. W. Hill, '73; S. G. Hobert, '96; T. J. Hollenberger, '09; G. L. Holzeimer, '08; F. H. P. Howard, '03; R. V. Howard, '09; C. M. Howe, '97; W. G. Howell, '96; O. L. Hunter, '97; A. H. Hutchinson, '10; P. E. Irvine, '07; K. G. Ives, '12; F. T. Jackman, '13; H. W. Johnson, '07; H. C. Jones, '02; I. O. Jones, '06; J. L. Jones, '06; J. P. Jones, '13; C. C. Keeler, '12; J. Kastner, '12; W. Kahl, '06; R. J. Kehl, '12; J. G. Kellogg, '06; A. T. Kirk, '99; J. Kirkman, '12; S. G. Koon, '02; F. A. Krehbiel, '01; H. E. Kritzer, '14; J. Kruttschnitt, '10; C. Kingsley, '94; A. L. Kuehmstead, '05; W. A. Kuhlmey, '05; T. B. Lambert, '87; W. A. Lamson, '04; C. M. Langfeld, '06; S. J. Larned, '90; J. M. Lee, '99; W. C. Lefens, '06; G. M. Leslie, '13; R. H. Lindman, '05; P. K. Lindsay, '16; F. H. Lockwood, '13; L. S. Louer, '94; W. Lytton, '08; E. T. McCarthy, '10; J. S. McDonald, '91; H. B. MacFarland, '02; W. G. McLaury, '07; G. E. Macy, '07; E. A. Magannis, '07; J. C. McMynn, '92; E. Magnus, '10; A. J. Mason, Jr., '10; R. C. Matlock, Sr., '93; F. Mathiesen, '95; F. Y. Mettenet, '12; R. C. Meysenburg, '99; K. B. Miller, '93; M. C. Miller, '99; S. N. Miller, '12; J. E. Mills, '14; M. J. Milmore, '97; W. J. Miskella, '05; J. H. Mitchell, '96; W. S. Monroe, '90; C. T. Mordock, '97; E. Monroe, '04; J. J. Munns, '14; L. E. Murphy, '12; J. C. Neely, '99; J. C. Nellegar, '98; F. E. Nellis '04; C. Netzorg, '05; W. R. Newcomb, '05; J. H. Newman, '15; P. A. Newton, '94; R. H. Newton, '05; G. R. Nicholls, Jr., '11; J. D. Nies, '04; L. M. Northrup, '02; W. J. Norton, '02; J. W. O'Leary, '99; I. J. Owen, '99; E. Page, '05; E. P. Palmer, '04; J. J. Patterson, '02; E. D. Payne, '07; J. C. Peebles, '08; L. J. Percy, '14; F. H. Philbrick, '07; A. E. Philbrick, '02; H. B. Phillips, '11; G. F. Pond, '10; S. A. Pope, '14; A. R. Porter, '04; H. F. Porter; W. S. Porter, '97; G. A. Post, '05; H. F. Prussing, '09; R. E. Prussing, '04; F. D. Purdys, '96; F. Raymond, '02; J. S. Reid, Jr., '09; J. E. Reinhart, '99; T. G. Remsen, '08; A. L. Rice, '96; G. W. Ristine, Jr., '01; J. D. Ristine, '04; E. M. Ritzwoller, '05; H. W. Robbins, '08; O. W. Roberts, '01; W. C. Robinson, '91; A. M. Rodelhew, '96; E. Root, '89; A. G. Rockwell, '08; D. W. Roper, '93; S. A. Russell, '12; W. E. Rudolph, '11; A. H. Sayce, '05; H. Scarborough, Jr., '07; C. S. Schaefer, '94; A. Scheible, '89; C. M. Seymour, '09; G. B. Shaw, '08; M. H. Sherman, '91; W. B. Simons, '12; W. A. Sibley, '06; T. H. Sidley, '03; H. S. Simpson, '96; L. Skipworth, '10; B. Solan, '07; A. R. Smith, '95; C. H. Smith, '85; R. B. Smith, '07; W. G. Smith, '92; G. L. Southard, '01; H. E. Southard, '13; F. E. Stark, '12; J. E. Steever, '03; D. P. Stearns, '03; F. V. Stewart, '04; C. F. Stocking, '95; A. H. Stocking, '95; J. A. Stratton, '04; S. H. Sutton, '11; D. R. Swinton, '11; H. Tilson, '13; S. K. Throckmorton, '09; A. C. Townsend, '95; H. L. Trube, '08; R. Tschentscher, '98; R. C. Turner, '06; R. W. Ullman, '08; D. T. Vanderlyn, '14; L. M. Viles, '04; C. Wait, '12; A. W. Wakeley, '11; L. D. Webster, '08; T. K. Webster, Jr., '03; E. C. Wegman, '10; A. W. Wigglesworth, '93; J. R. Wilbur, '97; E. P. Wilder, '05; E. T. Wilder, '06; A. Whittemore, '03; C. F. Wiley, '07; L. T. Wilson, '02; H. D. Wheeler, '13; H. L. Wheeler, '13; H. J. Wise, '06; F. B. Wipperman, '13; L. Woodland, '06; A. H. Woodward, '92; P. B. Woodworth, '08; W. C. Yeatman, '99; J. G. Allbright, '17; W. E. Goodman, '17; L. C. Huck, '17; J. H. Vickers, '17.
Danville. T. D. Allen, '95; R. H. Sherwood, '97; D. F. Stevens, '07.
Decatur. G. A. Lytle, '93; C.W. Lake, '14; L.W. Mueller, '17; W. M. Stowell.
Divernon. S. R. Johnson, '97.
Dixon. J. O. Dodge, '04; W. D. Hart, '10.
East Moline. L. A. Murray, '94.
Edgemoore. J. S. T. Beardslee, '92.
Elgin. A. L. Clark, '14; L. K. Malvern, '94.
Evanston. D. Alexander, '14; C. C. Cheney, '11; W. C. Collyer, '15; P. H. Gilleland, '08; R. I. Graves, '07; T. W. Heermans, '82; C. Z. Henkle, '15; W. H. Kasfer, '14; H. D. Nitchie, '97; R. S. Lasher, '14; J. S. Somerville, '07; R. W. Turner, '14; J. Lyman, '95; A. M. Wright, '17.
Galesburg. R. F. Carley, '07.
Glencoe. W. G. Copeland, '10.
Hanny. W. C. Dyer, '07.
Harvey. H. B. Boies, '16; N. S. Lawrence, '05; A. L. Walter, '89.
Hawthorne. L. T. Hamplin, '15; C. L. Johnson, '97.
Highland. L. Amman, '97.
Hubbard Woods. F. W. Parker, '11.
Ilion. P. S. Jones, '05.
Joliet. F. Adam, '04; R. Adam, '89; R. S. Baum, '10; R. S. Barber, '17; H. H. Bates, '06; W. O. Bates, '11; M. R. Jonas, '11; J. F. Moffat, '06; K. Robinson, '14.
Kenilworth. J. C. Carpenter, '08; S. S. Holden, '05; G. R. Lester, '13.
Kewanee. C. E. Bronson, '10; L. Etshokin, '17.
Lacon. H. A. Ingram, '11.
La Grange. R. B. Hayward, '99.
Mattoon. H. H. Wood, '12.
Maynard. E. M. Richardson, '97.
Milford. L. M. Goldstein, '07; Q. A. Hall, '07.
Moline. H. L. Benster, '15; J. Bushong, '02; E. D. Church, '89; G. S. Goodwin, '99; O. W. Howard, '08; W. H. Van Dervoort, '93.
Murphysboro. H. E. Wilson, '05.
Oak Park. M. E. Berry, '05; C. W. Bradley, '96; H. W. Caldwell, '17; J. A. Erwin, '07; I. S. Jones, '06; D. R. Scholes,; E. P. Wand, '05; W. R. Wheeler, '12; A. F. Wilcox, '91; C. G. Yerkes, '11.
Ottawa. H. R. Center, '93.
Pekin. J. S. Loomis, '90.
Peoria. W. H. Ballance, '06; J. T. Hunter, '96; C. E. Moulson, '04; R. Page, '04; J. A. West, '00; M. C. Wheeler, '87.
Pontiac. W. F. Goode, '05.
River Forest. W. Bentley, '98; E. C. Homer, '17.
Riverside. S. Montgomery, '10.
Robinson. C. Everingham, '12.
Rockford. C. F. Bollman, '12; L. H. Clark, '00; E. D. Parker, '01; M. P. Roper, '14; J. F. Nelson, '91.
Rock Island. E. R. Guyer, '15.
Springfield. F. Ide, '92; J. Lewis, '81.
Sterling. W. A. Robinson, '06; S. Williams, '94.
Urbana. A. M. Buck, '04; J. W. Davis, '10; H. F. Moore, '03; C. R. Richards, '05; E. W. Waldo, '90; L. A. Wilson, '09.
Waukegan. B. C. McFadden, '08.
Western Springs. A. W. Cornell, '11; J. S. Knoalson, '05.
Wilmette. A. M. Rossman,'06; D. K. Dickinson,'91; D. H. Nicholls,'96.
Winnebago. G. Parsons, '04.
Winnetka. H. E. Barroll, '05; W. A. Thrall, '05.
Wynette. L. T. Hall, '88.

INDIANA

Albion. A. Black, '99.
Anderson. B. F. Haugh, '15.
Cambridge City. G. F. B. Grendlinger, '96.
Connersville. G. C. Hicks, Jr.; Y. R. Schively, '17.
Crown Point. H. P. Broughton, '90.
Evansville. W. H. Loewenthal, '05; R. Rosencranz, '05.
Ft. Wayne. J. A. Bursley, '01; C. R. Branson, '01; T. J. Brown, '10; J. B. Crankshaw, '92; W. S. Goll, '96; G. Lucker, '06; W. G. Massey, '01; A. H. Schaaf, '06; T. W. Voetter, '92.
Gary. T. D. Hodge, '98.
Hammond. W. L. Wilke, '09.
Huntington. H. E. Oskamp, '07.
Indianapoils. H. N. Baxter, '13; H. W. Bliss, '09; A. J. Boardman, '08; W. H. Block, '11; H. C. Carroll, '03; W. J. Dann, '08; F. L. Druliner, '95; E. H. Eitel, '07; W. W. Kuhn, '09; C. Latham, '04; E. H. Mayo, '05; J. M. Moffatt, '14; W. E. Munk, '12; L. J. Osborn, '96; E. W. Piel, '04; A. L. Piel, '04; C. S. Ricker, '11; W. E. Ricketson, '07; H. C. Tinney, '96; C. P. Wilson, '92; A. Vonnegut, '05; R. D. Zener, '07; S. C. Wilson., '17.
LaFayette. H. H. Scofield, '05; R. W. Wallace, '01; H. L. Watson, '11.
Lawrenceburg. C. S. Diehl, '07.
Mishawka. G. W. Blair, '10; E. H. Merrick, '08; S. C. Stocker, '10.
New Albany. A. F. Hegewald, '87; M. T. Insull, '93; E. C. Hegewald, '93.
Notre Dame. W. L. Benitz, '96.
Otterbein. L. E. Baker, '06.
Portland. W. A. Drake, '06.
Richmond. T. J. Cambell, '12; S. W. Hayes, '91.
South Bend. W. B. Calvert, '90; H. D. Johnson, Jr., '04; P. Clark, '99; C. D. Smith, '17.
Terre Haute. C. B. Gorby, '96.

IOWA

Ames. C. C. Major, '98; W. H. Meeker, '91.
Cedar Rapids. J. C. Brocksmit, '99; A. E. Ferguson, '05; G. G. Keeler, '06; J. C. Young, '94.
Clinton. D. S. Seaman, '13.
Davenport. H. O. Koehler; H. R. Lafferty, '11; W. Ransom, '99; W. Smith, '09; H. W. Struck, '13.
Decorah. W. M. Hogle, '06.
Des Moines. R. P. Heath, '11; J. R. Longwell, '13; W. H. Thomson, '98; C. W. Schmidt, '17.
Dubuque. E. C. Loetscher, '99; A. Y. McDonald, '91.
Garden Grove. T. J. Wilkin, '94.
Mason City. W. J. Maytham, '02.
Montezuma. E. N. Harris, '08.
Muscatine. R. S. Willis, '07.
Onawa. C. G. Oliver, '92.
Postville. L. H. Luhman, '10.
Waterloo. A. Burt, '00; T. C. Menges, '94; H. B. Plumb, '01; R. E. Rondebush '07.
Woodbine. H. A. Kling, '06.

KANSAS

Galena. R. W. Titus, '13.
Independence. N. K. Moody, '99.
Lawrence. P. T. Walker, '01.
Manhattan. J. E. Jenkins, '16.
Maple Hill. F. A. Adams, '14.
Parsons. W. Maddocks, '88.
Pittsburg. H. C. Givens, '01.
Topeka. H. Hackney, '77; M. H. Haig, '00; G. C. Molleson, '13.

KENTUCKY

Anchorage. W. Bowser, '06.
Lexington. C. B. English, '01.
Louisville. R. E. Branders, '97; E. P. Chapin, '93; H. L. Hupe, '09; M. W. Davidson, '14; W. H. Lovejoy, '08; C. H. Mourning, '06; E. A. Stege, '90; A. L. Terry, '08; O. P. Ward, '96; G. L. Weller, '97.
Owensboro. F. S. Brannon, '08.
Paducah. F. S. Lack, '16.

LOUISIANA

Baton Rogue. C. H. Kretz, '98; D. Stewart.
Jena. W. Baker, '17.
Lake Providence. G. T. Hider, '09.
Manchae. E. J. Lefebvre, '04.
Morgan City. B. A. Pharr, '01.
New Orleans. E. L. Aschoffenburg, '13; J. E. Brogan, '06; N. F. Bohne, '01; R. T. Burwell, '91; E. W. Carr, '01; J. G. Callahan, '14; E. H. Coleman, '12; I. Davenport, '04; G. H. Davis, '92; W. B. Gregory, '94; S. H. Menge, '06; J. K. Newman, '91; A. Ryder, '13; O. Schwartz, '07; F. J. Schwab, '03; E. J. Stearns; O. A. Torlicht, '08; J. Callan, '17.
Shreveport. E. L. Wheliss, '16.
Stidell. A. F. Pritchie, '16.

MAINE

Augusta. H. W. Eells, '02.
Bangor. H. D. Seavy, '01.
Bath. W. R. Dean, '04.
Bowdoinsville. V. C. Dunlap, '16.
Clarks Mills. M. N. Clark, '12.
Farmington. H. Greenwood, '72.
Kingfield. F. A. Crossman, '90.
Lewiston. L. R. Longfield, '13.
Machias. E. G. Gilson, '94.
Paris. G. A. Wilson, '02.
Portland. H. Wheeler, '14; C. T. Gilmore, '09; E. G. Kluge, '13.
South Paris. C. G. Morton, '05.
Stetson. G. D, Hersey, '75.

MARYLAND

Annapolis. E. W. Iglehart, '99.
Arlington. H. C. Emich, '17.
Baltimore. S. B. Austin, '95; W. B. Beals, '02; W. B. Blakeslee, '03; G. W. Black, '14; J. Bowes, '07; W. A. Brown, '15; P. G. Burton, '94; N. E. Brice, '11; G. R. Callis, '09; J. J. Conen; R. V. Cook, '98; E. Constam, '16; F. Davis, '11; W. D. Dalrymple, '13; H. C. Resbecker, '08; L. S. Elmer, '93; G. W. Gail, '16; J. S. Gorrell, '05; C. B. Gill, '06; J. T. Graff, '00; E. H. Herzer, '16; A. Hughes, '12; A. P. Kelly, '10; G. M. Keller, '08; G. L. Kerr, '14; J. T. Kelly, '02; W. E. Lee, '11; C. R. Littig, '08; H. C. E. Louis, '06; A. J. Lowndes, '05; A. L. Malone, '06; A. D. Matthai, '10; F. H. McCormack, '10; E. G. Mergenthaler, '07; C. R. Mettee, '08; D. Miller, '08; W. R. Mitchell, '06; J. B. Norris, Jr., '13; E. S. Odenhal, '04; R. G. Pangborn, '08; G. A. Rasch, '15; G. E. Shepard, '88; D. W. Shilling, '12; S. H. Schapiro, '08; F. W. Seward, '09; O. W. Shilling, '12; H. G. Smith, '06; H. T. Snyder, '04; H. C. Stanwood, '13; W. R. Straus, '10; E. D. Struven, '01; N. W. B. Sturgis, '08; G. T. Sturmfels, '13; C. C. Thomas, '95; E. H. Thompson, '15; T. W. Todd, '07; R. M. Van Valkerburgh, '15; R. H. Wambaugh, '13; W. S. Wright, '12; E. L. Wolbe, '14; F. Zies, '02; P. H. Zipp, '05; O. H. Ham, '17; O. C. Shull, '17, R. C. Taylor, '17; E. H. Watkins, '17.
Chestertown. R. C. Leaverton, '98.
Chevy Chase. C. M. Marsh, '03.
Cockeyville. J. F. Matthai, '12.
Cumberland. M. A. Somerville, '11.
Darlington. J. F. Thomas, '08.
Forest Glen. F. W. Wright, '17.
Fort Washington. S. H. McLeary, '04.
Frederick. K. S. Toms, '03.
Frostburg. J. H. Twin, '12.
Highlandtown. C. Schluderberg, '11.
Luke. W. B. Rapley, '08.
Millington. V. P. Pennington, '17.
Mt. Wilson. M. N. Lyon, '09.
Parkton. J. P. L. Shamberger, '12.
Rockville. H. W. Talbot, '99.
Roland Park. K. E. Sommer, '96.
Roslyn. E. S. Choate, '03; R. P. Choate, '08.
Royal Oaks. C. I. Heikes, '12.
Silver Spring. G. R. Bliss, '06.
Sharon. H. Rigdon, '16.
Sparrows Point. C. H. Dyer, '16; H. W. Moffat, '10; J. A. Raidabaugh, '05; F. E. Lyford, '16; I. J. Stone, '16.
Towson. M. J. Nelligan, '14.
Westminster. I. S. B. Barth, '04.

MASSACHUSETTS

Adams. H. L. Follette, '11; C. V. Haworth, '07; R. C. Marcellus.
Amesbury. P. W. Blake, '12; H. A. Sawyer, '90.
Athol. R. L. Dexter, '10.
Auburndale. H. F. Jewett, '03.
Boston. F. H. Abbey, '01; A. D. Adams, '84; E. F. Aldrich, '92; H. R. Bangs, '14; W. Balcke, '07; A. H. Barber, '10; E. J. Bird, '07; W. S. Bishop, '06; C. W. Blood, '91; A. C. Blunt, '07; H. S. Brown, '04; H. T. Brown, '95; D. E. Burr, '03; W. A. G. Clark, '00; R. W. Conant, '09; F. C. Cosby, '93; L. W. Cottrell, '01; J. W. Cowles, '90; F. L. Cross, '93; R. B. Daggett, '94; C. Delano, '12; L. Eddy, '14; A. H. Eldredge, '88; N. W. Elmer, '04; W. F. Evans, '93; F. S. Farnham, '05; E. M. Fay, '09; C. B. Furgesson, '12; C. P. Goree, '13; C. F. Hackett, '98; H. Hale, Jr., '09; R. S. Hale, '93; J. L. Hall, '91; E. T. Hamlin, '96; B. K. Hough, '97; C. W. Hunter, '05; J. B. Ink, '12; M. S. Jones, '10; E. M. Kephart, '03; E. H. Lange, '12; J. R. Marvin, '02; H. R. Milner, '97; L. H. Parker, '89; P. Palyer, '03; F. G. Patterson, '00; L. R. Phillips, '12; T. H. Piser, '95; R. V. Proctor, '14; W. V. Randall, '10; A. A. Raymond, '99; R. P. Raynsford, '05; E. T. Richardson, '11; G. E. Robinson, '10; W. W. Roney, '05; A. E. Rowland, '12; E. J. Shiland, '03; F. G. Shull, '07; R. L. Littinger, '15; B. Smith, '04; W. N. Smith, '90; W. G. Starkweather, '92; H. W. Stevens, '14; F. A. Tennant, '93; E. L. Tiffany, '08; H. Van Evern, '91; C. W. Van Law, '96; R. L. Warner, '92; W. M. Watkins, '06; F. J. Wellhouse, '00; W. B. S. Whaley, '88; T. J. Whitehead, '96; W. Will; D. D. Williams, '06; J. Winslow, '11; G. K. Woodworth, '96; G. A. Wortman, '08.
Brockton. D. M. DeBard, '09; C. B. Thomas, '11.
Brookline. C. Fillebrown, '16; F. C. Fletcher, '94; F. W. Lieherknecht, '11; W. E. Pierce, '06; H. W. Porter, '17; J. W. Stoddard, '12.
Cambridge. C. K. Carpenter, '07; C. W. Dunn, '93; C. H. Landon, '16; L. S. Marks, '94; J. H. McIlvaine, '14; L. A. Merrihew, '10; P. E. Raymond, '02; G. H. Rockwell, '13; A. C. Roos, '03; W. S. Smith, '92.
Charlestown. G. E. Chapin, '94; E. C. Hayden, '99.
Chicopee Falls. W. S. Stockton, '16.
Dorchester. A. E. Bump, '00; J. E. Neary, '06.
Easthampton. P. B. Johnson, '10.
Fairhaven. P. W. Kinney, '06.
Fall River. A. Walton, '02.
Fitchburg. J. J. Hogan, '02; A. O. Hitchcock, '01; E. F. Simonds, '74.
Fort Andrews. A. E. Rowland. '13.
Great Barrington. C. G. Dalzell, '90; W. B. Wolcott, '11.
Greenfield. H. W. Kellogg, '84.
Gardner. J. A. Dickerman, '06; H. E. Drake, '11; H. F. Locke, '06.
Holyoke. R. G. Batchellor, '04; C. M. Boegehold, '06; F. P. Cleveland, '06; C. L. Dingens, '96; F. C. Heywood, '10; D. C. MacIntosh, '07; J. N. Magna, '06; E. M. Osgood, '04; F. M. Sears, '05; E. A. Stimson, '11; C. E. Torrance, '12; R. M. Weiser, '14; S. E. Whiting, '98.
Housatonic. T. S. Ramsdell, '03.
Lawrence. F. H. Schwartz, '05.
N. Leominster. F. C. Loomis, '14.
Lee. W. H. Rice, '16.
Lowell. A. S. Wells, '14.
Ludlow. P. G. Weidner, '02.
Lynn. H. Y. Blodgett, '15; H. G. Hamman, '92; R. J. Jones, '13; J. Walzer, '11.
Marblehead. S. G. Curtis, '96.
New Bedford. C. H. Reuman, '14.
Newton. H. L. Stevens, '95.
Newton Highlands. J. B. Wood, '13.
Newtonville. R. H. Higgins, '10; C. L. Tower, '10.
Newton Lower Falls. L. A. Beecher, '03; O. L. Farley, '10; J. B. Philips, '06.
Newton Center. H. A. Hageman, '99.
North Adams. F. E. Blake, '99; G. C. Hadley, '01.
Norfolk. L. E. Ware, '77.
Northhampton. S. E. Hickman, '05.
Orange. B. P. Dexter, '10.
Peabody. H. E. Davis, '07.
Pittsfield. C. E. Backman, '16; M. M. Chesney, '16; S. G. Colt, '95; S. Halle, '14; W. Insull, '15; J. C. Musgrove, '03; H. E. Robbins, '89; J. L. Robbins, '07; M. E. Sayles, '08; L. J. Smith, '99; G. A. Tilden, '09; H. W. Tobey, '97; F. R. Wallace, '11; G. E. Whittlesey, '09; W. A. Whittlesey, '04; E. D. Williams, '08.
Quincy. P. L. Reymond, '17; S. S. Wakeman, '99.
Reading. W. H. Marland, '01.
Roxbury. R. P. Tracy, '06.
Somerville. P. A. Wein, '06.
Springfield. W. A. Ballard, '93; H. W. Carey, '08; M. J. Hawkins, '02; E. N. Hay, '12; P. B. Johnson, '10; R. P. King, '12; M. J. Koustankewicz, '10; W. R. Manny, '13; W. L. Mulligan, '98; J. H. Newton, '06; A. J. Sheave, '11; D. B. Wesson, '06; A. G. Wylie, '05.
Sheffield. E. W. Curtis, '80.
South Hadley Falls. C. L. Strong, '12.
Stockbridge. B. Hoffman, '95; H. McBurney, '02.
Tufts College. E. McNaughton, '11.
Wakefield. W. F. Gilcreast, '07
Weymouth. H. D. Hyland, '14.
West Lynn. G. S. Bliss, '90.
Wellesley. G. B. Farnham, '06.
Worcester. G. I. Alden, '90; J. F. Comstock, '06; W. W. Hodge, '05; A. T. Knight, '12; C. R. Oliver, '08; O. G. Petterson, '15; J. O. Phelon, '01; C. T. Reed, '03; C. A. Roberts, '04; H. B. Smith, '91; C. R. Sturdevant, '92; R. B. Whyte, '13; H. Wyman, '16.
West Newton. F. W. Albree, '91.
Woronoco. H. A. Lincoln, '13.

MICHIGAN

Albion. L. E. White, '94.
Battle Creek. E. L. Branson, '95; W. S. Bryde, '09; G. R. Burt, '96; G. A. La Fever,; H. B. Foote, '04.
Bay City. L. Gross, '03; R. G. Handy, '10.
Benton Harbor. W. Endress, '97.
Calumet. R. McIntosh, '05; H. E. Williams, '95.
Detroit. T. F. Ahern, '94; R. V. Allison, '08; O. von Bachelle, '92; A. T. Baldwin, '96; S. G. Barnes, '92; C. L. Beaman, '08; E. H. Bingham, '96; F. F. Bontecow, '98; H. S. Bope, '04; R. Bragaw, '09; J. H. Brodt, '13; R. H. Brown, '08; W. A. Carter, '13; J. J. Chapin, '90; C. W. Cross, '01; V. N. De La Mater, '00; A. H. Doolittle, '04; F. L. Emerson, '06; G. M. Evans, '06; W. R. Ferris, '11; W. E. Flickinger, '08; C. W. Gail, '97; A. H. Green, '92; H. Green, '01; L. Hammond, '16; R. C. Hargreaves, '09; R. L. Hargreaves, '98; C. F. Harvey, '02; F. J. Haynes, '95; C. F. Hirshfield, '06; A. B. Hoffman, '05; C. C. Hope, '13; W. H. H. Hutton, '91; D. J. Jenkins, '92; G. F. Johnson, '07; R. W. Keeler, '07; C. B. King, C. H. Kinsman, '05; H. B. Knapp, '11; A. Knight, '01; R. P. Lay, '07; A. S. Mattison, '07; K. H. Mayer, '15; A. W. Mellowes, '06; E. Mendinhall, '16; H. H. Micou, '15; L. F. Murphy, '09; J. F. Naugle, '16; J. F. Norris, '07; V. Oldberg, '02; J. W. Parker,; D. W. Pence, '14; D. H. Reeves, '13; P. O. Reyneau, '13; S. C. Root, '01; A. L. Rose, '10; M. D. Sample, '94; F. W. Scheibner, '02; C. P. Shaw, '05; E. M. Shepard, Jr., '13; S. D. Sibley, '07; L. V. Spencer, '11; D. G. Stanbrough, '04; D. T. Stanton, '15; C. W. Stevens, '05; M. W. Stone, '14; H. A. Strickland, '07; P. W. Thompson, '10; E. D. Titchenor, '08; E. B. Tollman, Jr., '15; C. H. Treat, '94; R. S. Trott, '04; J. G. Utz, '02; A. C. Walser, '09; H. V. Welles, '13; J. F. Whitehead, '13; P. M. Wood, '13.
East Lansing. G. W. Bissell, '88.
Edwardsburg. H. B. Ketchum, '05.
Escanaba. G. M. Maskek.
Flint. J. L. Brown, '13; J. A. Bundy, '11; A. F. Constam, '13.
Grand Rapids. R. W. Cornell, '13.
Grosse Point Farms. D. McGraw, '13.
Iron Mountain. H. E. Rundle, '13.
Jackson. H. D. Clark, '09.
Kalamazoo. G. L. Erwin, Jr., '17.
Kearsage. W. H. Gallagher, '06.
Lansing. J. H. Gould, '06; D. S. Olds, '11; F. G. Seitz, '05; J. P. Thoman, '76; V. T. Wilson, '02.
Marquette. H. H. Williams, '94.
Menominee. C. S. Prescott, '11.
Monroe. L. Ochtman, Jr., '15.
Muskegon. C. L. Stevens, '16.
Munising. C. Barlow, '09.
Ontonagon. T. A. Green, '96.
Port Huron. S. G. Jenks, '97.
Red Jacket. W. E. Parnall, '95.
Saginaw. C. B. Curtiss, '09; R. H. Hubbell, '05; R. A. Lander, '12.
St. Joseph. B. S. McConnell, '08; H. M. McConnell, '07; R. Olney, '10; O. C. Schoenbeck, '05.
Sault St. Marie. B. G. Davidson, '16.
Stanton. T. S. Towle, '14.
Three Rivers. H. F. Bade, '14; W. F. Clayton, '14; A. P. Cottle, '07; W. S. Hovey, '97; H. Rose, '01; H. A. Temple, '06; H. E. Thompson, '02.

MINNESOTA

Deerwood. C. C. Adams, '05.
Duluth. C. M. Autremont, '11; A. E. Bannister' '13; T. D. Hodge, '08; K. C. Hoxie, '93; S. T. Meissner, '06; H. H. Talloys, '04; E. C. Wells, '98; W. H. Yates, '06.
Hibbing. G. A. Jahn, '08.
Minneapolis. M. E. Crosby, '16; E. R. Greer, '08; D. C. Hawley, '16; J. K. Hoppin, '06; S. S. Lawler, '14; T. S. McLaughlin, '92; G. W. Nielson, '06; H. J. Pierce, '09; G. W. Redfield, '02; H. C. Reid, '09; G. D. Shepardson, '89; G. R. Townsend, '92; A. D. Walker, '08; M. F. Warren; H. V. Whitney, '09; W. D. Whitney, '02; R. A. Parke, '17.
St. Cloud. A. Tileston, '08.
St. Paul. R. D. Cutter, '09; J. F. Druar, '01; R. E. Leonard, '09; H. M. McLufkin, '14; A. Miller, '11; W. R. Morgan, '96; F. S. Power, '13; K. B. Van Bergen, '15; C. R. Vincent, '08; E. A. Wilhelm, '90.
Winona. W. E. Dunham, '95.
Wilmar. A. M. Larson, '04.

MISSISSIPPI

Brunswick. L. Davis, '93.
Columbus. J. T. Seary, '95.
Crystal Springs. C. C. Spence, '01.
Jackson. F. H. Jones, '09.
Meridian. S. Eastland, Jr., '10; L. M. Threefoot, '11.
Pass Christian. D. W. Blake, '94.
Russum. A. M. Warner, '05.
St. Joseph. J. H. Van Brunt, Jr., '13.
Vicksburg. H. L. Allen, '10; S. M. Bullis, '08; O. H. Simonds, '08.
Water Valley. G. A. Wagner, '06.
Yazoo City. G. B. Twellmeyer, '96.

MISSOURI

Ash Grove. W. H. Barton, '08.
Carthage. J. E. O'Keefe, '98; J. Oliphant, '96.
Charleston. H. A. Danforth, '98.
Canton. H. D. Munday, '06.
Cameron. C. V. Ellicott, '11.
Columbia. F. K. Atkinson, '12; H. W. Hibbard, '91.
Flat River. G. W. Roddewig, '06.
Hannibal. R. A. Dittmar, '13; H. H. Kessler, '13; F. J. Robbins, '15.
Jackson. L. Sanford, '95.
Joplin. H. R. Conklin, '92; W. M. Leckie, '95.
Kansas City. G. H. Bollman, '16; C. R. Cook, '07; A. P. Denton, '04; J. F. Goodman, '99; W. L. Hearn, '02; C. L. Heflinger, '13; A. Hurlburt, '07; G. A. Kositzky, '05; R. R. Lally, '08; J. F. Meister, '05; J. W. Prince, '05; W. B. Richards, '83; J. H. Sternbergh, '13; H. T. Wheeler, '11.
Louisiana. D. P. Smith, '06.
Lumberton. H. H. Hinton, '07.
St. Genevieve. D. S. Hunkins, '04.
St. Louis. C. L. Allen, '10; L. B. Babcock, '72; B. C. Bascom, '14; F. E. Bausch, '96; C. B. Bennett, '15; E. A. Bentley, '95; S. W. Booth, '09; C. W. Brown, '13; W. G. Christy, '11; J. B. Carton, '01; W. H. Coffin, '06; F. D. Denton, '07; W. E. Doll, '11; H. H. Downes, '08; W. L. Eastman, '93; H. I. Finch, '96; W. P. Gruner, '07; C. L. Glasgow, '02; L. Hill, '09; W. B. Holman, '04; C. S. Ittner, '74; A. S. Langsford, '01; H. L. Lowe, '03; A. F. Lubke, '14; S. M. McDonald, '09; W. G. Merowit, '11; H. H. Morrisson, '98; W. N. Morrison, '96; J. C. Nulsen, '14; L. J. Peake, '11; G. T. Perry, '13; N. D. Preston, '08; E. E. Salesbury, '15; E. G. Samish, '06; H. C. Schuyler, '10; W. D. Smith, '13; H. Spoehrer, '09; H. G. Stevens, '13; A. L. Stockton, '14; E. R. Thompson, '10; A. H. Timmerman, '93; R. P. Turner, '09; R. T. Turner, Jr., '08; A. Von der Lippe, '08; E. C. Von der Lippe, '07; A. J. Widmer, '04; S. Wright, '12; W. C. Bliss, '17; R. O. Meyer, '17; A. P. Timmerman, '17.
St. Joseph. R. B. Daley, '14.
Springfield. W. M. Baldwin, '05.
Webster Groves. H. W. Brooks, '11; H. C. Cundall, '15; G. K. Miltenberger, '11; A. P. Whittemore, '96.

MONTANA

Anaconda. W. C. Capron, '08; G. H. Cunningham, '08; D. M. Kerr, L. Maxwell, '15.
Billings. P. Goan, '13.
Butte. H. H. Cochrane, '06; T. W. Eustis, '09; R. M. Hale, '96; W. W. Warren, '96.
Bozeman. S. A. Mendenhall, '94.
Cascade. W. C. Sweet, '05.
Deer Lodge. L. Williams, '03.
East Helena. A. B. Norton, '94.
Elliston. W. G. Mack, '80.
Great Falls. E. A. Ekern, '04; J. M. Kingsbury; D. H. O'Brien, '17.
Helena. H. C. Brown, '05; H. E. Longmaid, '14.
Hysham. H. H. Buckingham, '03.
Missoula. A. W. Richter, '99; H. M. Ferguson, '03.

NEBRASKA

Hartington. J. D. C. Smith, '03.
Omaha. J. C. Chadwick, '15; N. Comfort, '13; J. J. Hanighen, Jr., '17; F. W. Koenig, '16; W. H. Price, '04; C. Stoddard, 3d, '07; C. A. Thomas, '00.

NEVADA

Elko. W. Patterson, '86.
Goldfield. F. Evans, '96.
Reno. S. G. Palmer, '10.
Winnemucca. J. W. McCook, Jr., '08.

NEW HAMPSHIRE

Antrim. H. Cochrane, '90.
Berlin. C. D. Stahl, '17.
Charlestown. E. F. Bowen, '12.
Claremont. W. J. Brown, '16.
Dover. J. F. Shepard, '07.
Durham. C. E. Hewitt, '95.
Franklin. C. W. Stephens, '11.
Lancaster. H. B. Carpenter.
Manchester. A. L. Bradbury, '12; W. F. Higgins, '90.
Portsmouth. C. Conrad, '96.

NEW JERSEY

Allendale. G. M. DuMauriac, '01.
Ampere. A. P. Dunn, '13; F. B. Hynes, '09; H. E. White, '98.
Asbury Park. D. B. Holcombe, '12.
Atlantic City. G. L. Collins, '12; M. C. Rosenblatt, '11; W. C. Belliss, '17.
Arlington. C. J. Pope, '11.
Atlantic Highlands. W. K. Auchincloss, '99.
Bayonne. T. H. Boice, '94; T. C. Brown, '12; G. E. Day, '09; S. Goldberg, '16; F. G. Hummell, '15; S. W. Treat, '07.
Beach Haven. E. A. Phillips, '10.
Belman. F. C. Tag, '01.
Bernardsville. R. K. MacKenzie, '14; R. Nash, '15.
Bloomfield. R. C. Denny, '03; H. L. Hepburn '97; C. Southwick, '13; C. Stanley, '17; R. O. Sternberger, '16; R. W. Symonds, '13; S. J. Tydeman, '06.
Burlington. S. H. Packer, '13.
Bogota. H. C. Lamb, '03.
Boonton. J. B. Howell, '14; H. T. Wootton, '10.
Bordentown. T. D. Applegate, '02.
Bound Brook. G. W. Parkin, '11.
Butler. D. White, '17.
Camden. B. Blank, '13; C. A. Carpenter, '08; R. G. Coolbaugh, '03; W. D. Kerlin, '01; S. P. Howe, '02; P. Hooper, '13; S. M. Langston; W. Maenak, '16; W. H. Rogers, '09; H. L. Waterall, '06; C. F. Wesley, '10.
Caldwell. E. P. Vroome, '13.
Collingwood. C. F. Jefferson, '10; H. M. Kille, '13.
Dover. A. D. Couch.
East Orange. C. F. Bachman, '08; R. C. Berg, '12; A. G. Bogardus, '12; E. A. Briner, '01; L. B. Cooper, '05; O. F. Derr, '04; E. S. Jamison, '16; D. E. Morris, '11; P. K. Morrow, '05; H. N. Searles, '17; F. M. Simpson, '14; R. P. Tobin, '96; H. B. Van Volkenburgh, '12.
Elizabeth. J. N. Brewster, '11; M. W. Buchanan, '00; A. Loomis, '10; E. C. Marsh, '08; D. M. Smith, '14; F. L. Newcomb, '13; E. A. Palmer, '09; F. D. Schneider, '06; A. F. Stillman, '07; H. L. Zabriskie, '98.
Elizabethport. R. M. Kline, '98.
Englewood. A. G. Trumbull, '99.
Englewood Cliffs. J. M. Ropes, '17.
Freehold. W. M. Hepburn, '11; C. D. Snyder, '13.
Fort Hancock. R. S. Oberly, '08.
Glen Ridge. H. G. Webb, '05.
Greenlock. O. F. Woodworth, '08.
Hackettstown. F. L. Cooke, '95; T. G. Plate, '96.
Hackensack. W. R. Schoenborn, '05; D. H. Ward, '11; F. T. Warner, '10.
Haddonfield. G. W. Loos, '75.
Harrison. W. A. Cather, '12; E. C. Sickles, '90.
Haskell. J. Lynah, '05; R. W. Wiggins, '11.
High Bridge. C. B. Andrews, '02.
Hoboken. J. H. Scott, '08.
Jersey City. H. K. Berger, '15; W. N. Cook, '00; L. B. Daumont, '09; E. H. Hartnett, '06; C. R. Haskell, '08; W. S. Hurwitz, '11; C. M. Husted, '09; C. H. Lewis, '08; J. P. McLean, '98; V. E. Mann, '73; W. H. Rose, '97; L. H. Snyder, '06; F. B. Straford, '95; H. D. Tompkins, '10; T. D. Voorhees, '01; C. M. Vreeland, '89.
Leonardo. C. A. Philippi, '15.
Long Branch. O. B. Hughes, '11; S. H. Hunt, '04; E. V. Hughes, '11; C. A. Slocum, '06.
Madison. H. R. Coffin, '08.
Manosquan. O. Bailey, '03.
Maplewood. W. R. Landmesser, '17; H. B. Peavey, '07.
Marlboro. C. H. Bertholf, '93.
Marksboro. F. B. Lanning, '12.
Matawan. W. V. A. Clark, '09.
Merchantville. G. W. Cole, '80.
Midvale. J. A. Garbarino, '17.
Montclair. S. Brown, '11; R. S. Brown, '14; P. T. Coons, '09; A. N. Delano, '03; F. H. Dutcher, '17; G. F. Hewitt, Jr., '10; J. R. Hogan, '11; E. Johnson, '99; E. W. McDougall, '06; D. G. MacVicar, '15; F. B. Miller, '13; C. W. Old, '95; H. S. Rowland, '06; G. H. Stickney, '96; E. J. Snow, '04; R. M. Wilson, '96; H. C. Zieger, '14.
Montvale. C. V. Ter Kuine, '14.
Mountain Lakes. R. W. Post, '11.
Morristown. P. M. Busby, '15; T. J. Murphy, '11; R. F. Sturgis, '10; R. D. Wooldridge, '96.

Newark. H. A. Benedict, '91; S. Benedict, '15; B. H. Blood, '89; T. I. S. Boak, '14; E. S. Bolgehold, '08; H. F. Burr, '08; H. E. Carver, '07; A. L. Chapin, '10; R. J. Cross, '11; R. E. Danforth, '91; H. E. Eberhardt, '06; S. P. Edmunds, '93; G. D. Gates, '09; F. W. Hay, '15; C. W. Johnson, '07; F. H. McCall, '93; F. Martin, '00; G. Meeker, '92; W. G. Mennen, '08; W. A. Murray, '06; C. A. Phillippi, '15; G. H. Phillips, '77; C. Pullin, '73; M. B. Rosewear, '08; F. L. Russell, '12; J. E. Rutledge, '11; P. Smith, '00; T. C. B. Snell, '93; E. A. Wadsworth, '04; A. C. Walther, '97; J. B. Warren, '73; W. A. Yerzley, '92.
New Brunswick. S. B. Carpender, '07; H. Koblenzer; W. E. Phillips, '14.
Newton. J. R. Howell, '11; C. C. Iliff, '16; J. R. Roof, '14.
North Branch. C. T. Darby, '06.
Orange. B. Cohn, '14; J. E. Brinckerhoff, '17; R. P. De Laval, '12; J. V. Miller, '01.
Passaic. W. E. Swigert, '07.
Palisades. R. S. Newcomb, '07.
Paterson. G. Ash, '13; D. D. Cooke, '15; S. A. Ellenbogen, '08; W. G. Fletcher, '10; M. T. Hartung, '08; G. F. Meyers, '12; J. Scarr, '05; L. F. Strickler, '13; R. L. Weber, '05.
Perth Amboy. L. J. Brennan, '14; R. J. McNitt, '04; L. Rehr, '09.
Plainfield. M. G. Allison, '16; M. F. Benton, '96; H. L. Blood, '13; K. J. Browne, '15; G. W. English, '08; I. A. Hunting, '02; J. S. Kenyon, '07; W. C. Morgan, '06; F. S. Overton, '01; C. M. Rittenhouse, '10; C. L. Riley, '99; J. V. Rittenhouse, '04; C. C. Rocap, '08; W. C. Simpson, '10; A. W. Stone, '94.
Phillipsburg. C. T. Chapman, '15; F. W. Lee, '15.
Princeton. C. M. Updike, '13.
Rahway. F. H. Randolph, '17.
Red Bank. J. E. Coleman, '02; A. B. Dalby, '96; J. B. Throckmorton, '08.
Ridgewood. E. B. Cooke, '17; L. F. Green, '13; C. W. Vocke, '00; C. W. Vail, '16.
Riverton. L. P. Warner, '03; H. M. Rogers, '07.
Riverside. V. Ritschard, '11.
Roseland. G. R. Leonard, '17.
Roselle. E. A. Stillman, '08.
Rutherford. G. S. Hamlin, '13; F. E. Wood, '13.
Sewarn. A. B. Boynton, '03.
Somerville. A. W. Mack, '90.
Summit. C. A. Berry, '99; G. H. Hodenpyl, '10; W. A. Larned, S. D. Mills, '13; H. G. Wisner, '11; J. H. Wisner, '03.
Stewartville. W. H. Mason, '00.
South River. A. Fitz, '10.
Trenton. E. C. Crosby, '10; P. A. Franklin, '13; C. T. Hanks, '13; C. E. Murry, '12; D. C. Oliphant, '11; G. B. Page, '11; W. E. Sanders, '03.
Upper Montclair. H. C. Blackwell, '05; E. Cairns, '06; H. A. R. Conant, '15; D. S. Henry, '11; H. C. White, '95.
Vineland. T. A. Mosscrop, '93; T. R. Taylor, '12; D. H. Chandler, '17.
Verona. W. C. Coniff, '97.
Washington. J. T. Drake, '99.
Weehauken. L. R. Claflin, '10.
Warristown. H. B. Viedt, '15.
Weedham. P. A. Freeman, '16.
Wenonah. C. S. Dawson, '09.
Westfield. W. H. Maxwell, '11; H. F. Welch, '10.
Westville. G. K. Coleman, '17.
Woodstown. E. R. Riley, '04.

NEW MEXICO

Elephant Butte. W. C. Beatty, '03.
Myndus. W. E. Stockwell, '03.

NEW YORK

Addison. C. M. Connor, '11.
Albany. F. Avery, '09; E. P. Bradley, '07; I. Buck, '04; M. C. Carpender, '05; R. F. Clapp, Jr., '10; W. J. Coffin, '98; J. W. Cox, '09; T. R. Cox, '11; C. A. Cremer, '13; H. M. Douglass, '07; T. Farmer, '05; W. Fitzpatrick, '97; W. Haag, '11; C. G. Hadley, '07; J. W. Hanford, '09; W. C. Harrington, '13; F. W. Kelley, '93; J. H. Lawrence, '09; E. H. Powley, '02; C. H. Ramsey, '17; J. H. Ramsey, '06; F. N. Sanders, '92; J. M. Taylor, '88; I. H. Vroman, '02; B. F. Witbeck, '07; G. W. Woodward, '09.
Albion. J. S. Beckwith, '04.
Alexandria Bay. C. L. Thompson, '06.
Allaben. H. B. Carpender, '15.
Amsterdam. G. D. Conlee, '08; G. V. Greene, '95; W. H. Inman, '12; J. H. Wilson, '04.
Angelica. R. W. Haines, '06.
Astoria. C. C. Atwood, '01; N. J. Sperling, '98.
Attica. M. M. Wheeler, '14.
Auburn. J. W. Ackerman, '97; C. A. Franke, '11; W. L. Hickstein, '07; J. M. Mowery, '99; E. H. Pierce, '92; W. R. Ramage, '17; T. S. Richardson, '01; A. W. Seacord, '09; S. Taber, '99.
Au Sable Forks. H. R. Graves, '91.
Babylon. H. S. Johnson, '99.
Ballston Spa. W. H. Namack, '01.
Barnards. K. B. McEwen, '94.
Batavia. D. W. Tomlinson, '94.
Bayside. J. H. Story, '91.
Baldwinsville. W. Morris, '93.
Bemis Point. C. A. Brown, '13.
Binghamton. M. C. Beman, '05; A. G. Breckenridge, '89; A. W. Deyo, '13; A. M. Fancher, '11; E. A. Hall, '04; E. C. Hyde, '16; M. P. Murray, '09; W. W. G. Murray, '16; P. F. Titchener, '13; E. S. Truesdall, Jr., '14; G. H. Young, '00.
Bolton Landing. S. Wells, '05.
Brockport. W. K. Lee, '14.
Brooklyn. G. W. Aldrich; R. K. Austin, '16; H. J. Babbidge, '11; C. G. Beavers, '10; J. M. Borden, '78; P. Brady, '14; J. W. Braffette, '15; A. W. Bushman, '13; W. M. Brown, '01; W. H. Browne, '06; C. Burns, '09; J. S. Burr, '93; H. C. Bushnell, '02; E. W. Butler, '13; F. Black, '16; E. Cairns, '06; J. A. Campbell, '04; A. T. Carter, '10; W. L. Casper, '08; H. A. Chapin, '15; H. W. Chapman, '00; H. G. Cisin, '14; H. R. Cobleigh, '01; R. Christensen, Jr., '10; E. Cockrell, '06; M. Cohen, '08; H. L. Collins, '95; H. P. Corwith, '16; J. V. Cooper, '96; G. H. Crawford, '10; F. R. Crowell, '12; G. T. Curnow, '84; P. Cushing, '06; H. E. Dann, '08; D. Darrin, '11; F. Dexter, '98; F. S. Dix, '03; S. R. Dresser, '12; H. Duryea, '07; S. W. Edlund, '12; C. M. Eshelman, '98; C. J. Focke, '97; K. G. Glover, '97; B. P. Goldman, '14; C. P. Gross, '10; F. W. Hackstaff, '05; H. C. Halstead, '14; M. T. Hand, '97; G. C. Hannan, '13; A. E. Hatch, '16; D. Haynes, '15; R. Hart, '16; C. Hartford, '10; E. H. Hendrickson, '06; G. S. Hendrickson, '11; V. O. Herriman, '08; A. M. Hess, '12; L. E. Herrmann, '13; S. V. Higley, '94; H. H. Hilborn, '96; F. D. Hooper, '07; W. E. Hoschke, '08; B. Houghton, '92; F. W. Hoyt, '08; H. D. Humpstone, '08; G. P. Jackson, '08; T. I. Jones, '96; H. B. Joyce, '12; W. N. Keenan, '11; W. E. Kennedy, '12; W. M. Keppel, '10; M. B. Keyser, '93; E. W. Kleinert, '16; A. Corbert, Jr.,; W. L. Kraemer, '12; G. W. Kuhn, '05; L. C. Lane, '12; S. J. Leffler, '07; W. J. Lewis, jr., '11; H. C. Lockwood, '12; A. M. Loughran, '10; G. M. Lynes, '15; E. McFarlan, '08; D. McMeeken, Jr., '03; C. W. McKay, '06; W. W. Macon, '98; E. A. Main, '07; S. T. Martin, '13; D. A. Mason, '94; J. Maddren, '72; L. E. Meeker, Jr., '04; G. H. Merrill, '96; W. Merrill, '03; D. W. Mesick, '80; O. Minton, '08; H. P. Moran, '03; L. Morgan, '00; R. P. Morse, '03; W. A. Mosscrop, '88; J. A. Myrick, '14; C. W. Nichols, '06; C. W. Nichols, '99; L. G. Nightingale, '06; W. E. Osterhaut, '11; K. D. Pettie, '12; G. M. Pearsall, '15; H. G. Peck, '93; C. M. Phinney, '14; J. E. Picard, '15; A. M. Powers, '10; N. D. Preston, '08; L. H. Quick, S. S. Rathburn, '09; F. C. Rice, 08; C. M. Riker, '96; R. B. Rodriguez, '15; L. C. H. Roesel, '08; J. D. Ross, '12; O. Rothmaler, '13; H. C. Russell, '16; F. Siefke, '04; R. L. Schultheis, '08; H. I. Silverman, '12; C. T. Smith, '96; F. G. Smith, '08; H. E. Smith, '14; H. V. Smith, '13; H. Smithers, '10; A. K. Sloan, Jr., '09; E. G. Sperry, '15; E. W. Stearns, '02; W. A. Taylor, '15; F. G. TenBroeck, '95; E. I. Thompson, '08; H. J. Treganze, '98; J. W. Turnbridge, '96; S. S. Turnbridge, '01; A. L. Voege, '99; D. W. Wallace, '13; R. O. Walbridge, '10; A. S. Wardwell, '06; A. B. Williams, '06; E. D. Williams, '03; L. B. Williams, '14; R. Wilson, '07; W. T. Wright, '08; W. H. Zabriskie, '13; S. M. Barr, '17; H. N. Bick, '17; J. C. Caldwell, '17; E. M. Cohen, '17; R. O. Compton, '17; L. M. Corliss, '17; L. J. Galbreath, '17; J. G. Gates, '17; R. L. Hambleton, '17; J. D. McChesney, '17; J. E. Matthews, '17; H. G. Meissner, '17; C. F. Ogren, '17; L. L. Richardson, '17; C. H. Spreckels, '17.
Buffalo. E. Adler, '09; A. H. Alberger, '93; J. Atkinson, '13; C. E. P. Babcock, '80; C. K. Bassett, '14; F. W. Bailey, '01; R. S. Bassett, '16; A. H. Baxter, '08; F. D. Bosche, '04; K. E. Battey, '15; C. H. Bierbaum, '91; F. B. Bissell, '92; C. A. Bierman, '14; W. L. Bradley, '08; O. S. Bruce, Jr., '08; A. S. Capwell, '92; G. E. Carman, '13; W. H. Carrier, '01; O. H. P. Champlin, Jr., '14; R. T. Chase, '09; C. E. Chatfield, '08; W. H. Coit, '13; H. Coward, '01; E. H. Croll, '09; G. S. Crosier, '06; H. C. Daggett, '16: A. M. Darlow, '06; C. W. Dean, '09; H. B. Downe, '15; R. R. Drake, 05; L. Dreyer, '11; G. H. Dyett, '97; A. C. Finlay, '12; H. M. Gail, '02; V. J. Guenther, '07; F. A. Haist, '11; C. G. Hardi, '02; H. J. Helfrich, '13; W. G. Hickman, '11; E. Hohner, '06; D. J. Howard, '16; F. D. Huntington, '00; F. D. Jackson, '02; L. C. Jackson, '91; N. M. Jameson, '11; M. Janowitz, '11; A. L. Jones, '06; E. W. Jones, '06; K. G. Kaffenberger, '13; L. A. Kendall, '96; C. M. Kennedy, '09; E. E. Kiger, '98; W. G. King, '94; T. C. Knight, '05; O. F. Kronenberg, '09; W. M. Ladd, '06; E. G. Lautz, '15; W. L. Lautz, '12; M. G. Lehman, '10; J. P. Lockhard, '09; H. H. Lyon, '01; J. B. McKee, '14; J. H. Madden; E. C. Mann, '97; C. A. Magoffin, '07; H. R. Mallory, '15; C. W. Mason, '05; A. H. Messersmith, '13; W. M. Meyer, '10; H. H. Miller, '11; A. H. Moran, '17; W. A. Morf, '13; C. D. Moses, '97; S. C. Moss, '05; V. C. S. Mott, '95; F. E. Munschauer, '07; S. Names, '12; S. A. Neubauer, '15; F. D. Newbrook, '13; E. D. Newkirk, '02; H. S. Norris, '15; W. W. Nowak, '05; J. J. O'Brien, '07; E. C. Olin, '84; R. N. Olin, '16; D. O. Palmer, '13; F. C. Perkins, '91; A. G. Peterson, '09; W. H. Pop, '15; D. F. Potter, '15; S. M. Quackenbush, '14; F. G. Raichle, '86; F. M. Remick, '05; H. C. Rice, '05; W. E. Robertson, '95; H. Rockwood, '09; C. J. Roese, '16; J. M. Rogers, '15; E. R. Ryder, '15; M. D. Salisbury, '07; E. H. Sawers, '10; W. H. Schoellkopf, '08; W. G. Seyfang, '09; H. W. Shaw, '15; H. H. Simons, '15; J. Y. Slowan, Sr., '94; H. H. Smith, '16; F. C. Stephens, '08; J. C. Talcott, '09; R. H. Tifft, '09; R. L. Tate, '11; N. N. Tilley, '13; E. H. Tingley, '09; F. C. Torrance, '11; J. C. Trefts, '02; D. Upton, '90; W. A. Van Houten, '10; E. F. Wendt, '11; E. L. Wilke, '12; R. N. Wing, '11; E. A. Wright, '08; R. A. Wright, '05; G. W. Wurst, '02; E. F. Zimmerman, '91; D. J. Howard, '17; C. F. Lautz, '17; T. V. Lautz, '17; W. E. Wroth, '17; H. C. Smith, '17.
Bronxville. R. O. Stillwell, '95.
Carmel. L. C. Ryder, '14.
Carthage. G. D. Ryther, '89.
Cayuga. J. Y. Davis, '72.
Canajoharie. A. C. Sticht, '96; W. N. Smith, '74.
Canandaigua. G. C. Roat, '06.
Canaseraga. W. H. Hampton, '89.
Canastota. M. DeLano, '95; N. L. Stafford, Jr., '11.
Camillus. R. B. Lea, '15.
Catskill. F. H. Hazzard, '96.
Cazenovia. K. P. Beardslee, '05; C. E. Davis, '12.
Cedarhurst. W. E. Hicks, '06; R. Pratt, '09.
Centerville. V. B. Barnum, '06.
Chazy. R. J. McCullough, '09.
Chelsea-on-Hudson. J. L. Collyer, '17.
Chippewa Bay. W. W. Wood, '99.
Cohoes. W. G. Nicholls, '02; N. L. Smith, '97.
Clarence. G. A. Kraus, '93.
Clayton. A. F. Barker, '06.
Clayville. B. T. Babbitt, '97; J. R. Benbow, '10.
Clinton. G. C. Bronson, '97.
Clockville. F. A. Clock, '09.
Cold Spring. G. W. Mosher, '07.
Cold Springs Harbor. J. Chase, '02.
Churchville. C. G. Winslow, '15.
Coney Island City. W. D. Potosky, '04.
Corinth. L. Randall, '14.
L. W. Law, '04.
Cooperstown. A. L. Johnson, '12; W. E. McGown, '04.
Corning. R. W. Canfield, '10; J. Rising, '13; O. P. Robinson, Jr., '15; V. L. Uhl, '16.
Cornwall-on-Hudson. S. C. Jones, '90.
Cortland. W. N. Brown, '05; D. G. Case, '06; E. H. Clark, '09; G. H. Higgins, '09; W. E. Titchener, '17.
Crystal Run. R. S. Ackerly, '11.
Dansville. G. MacNob, '13.
Deposit. F. A. Lovejoy, '12.
Delhi. G. M. Peake, '14.
Depauville. H. F. Halliday, '03.
Derby. S. R. Mann, '99.
DeRuyter. A. K. Schellinger, '09.
Dobbs Ferry. D. L. Dunbar, '13.
Dolgeville. H. N. Diederichs, '17.
Duane. W. K. Beryl, '13.
Dunkirk. J. A. Cook, '15; E. C. Haggett, '92; H. C. Long, '13; A. C. Schrader, '14.
East Aurora. R. D. McMillan, '10.
East Bloomfield. M. J. Phillips, '03.
East Randolph. M. F. Beardsley, '14.
Ellenville. J. E. Bailey, '09; J. H. Divine, '05.
Elmhurst. F. K. Pearce, '08.
Elmira. F. F. Abbott, '14; C. I. Baker, '09; E. B. Billings, Jr., '14; G. H. Carrier, '01; J. H. Costello, '06; E. F. Church, '76; E. E. Clark, '92; S. S. Comfort, '98; W. W. Cowan, '15; F. E. Doolittle, Jr., '11; C. S. Dudley, '13; C. F. Hall, '93; W. B. Hoffman, '15; H. F. Houck, '17; L. T. Ketchum, '04; A. Mason, '04; H. M. Sliter, '08; A. N. Smith, '09; J. T. Thompson, '11; G. W. Tidd, '13.
Elmsford. W. A. Moore, '09.
Fort Plain. E. Ornelas, '15.
Far Rockaway. H. L. Caldwell, '10; P. M. Scott, '13.
Fishkill-on-Hudson. F. R. Benjamin, '99.
Floral Park. J. M. Rudiger, '81.
Flushing. W. G. Berryman, '04; F. A. Collins, '15; H. W. DeVed, '03; J. J. Herrick, '91.
Freeport. L. J. Hall, '96.
Forestville. E. M. Adye, '07.

Franklinville. J. C. Howard, '04.
Friendship. G. R. Norton, '06.
Fredonia. F. M. Babcock, '04; A. E. Shero, '10.
Fulton. L. W. Emerick, '91; F. B. Dilts, '94; H. C. Perkins, '15; K. P. Royce, '16.
Fultonville. H. V. Cross.
Gage. D. R. Comstock, '14.
Garden City. H. M. Krumbhaar, '03.
Geneva. C. A. Blaine, '10; H. D. Henison, '09; W. Howard, '96; H. O. Palmer, '07; J. M. Sharpe, '99.
Gilboa. F. S. Mackey, '10.
Gillette. G. A. Cornish, '93.
Glen Cove. S. W. Mudge, '13.
Glens Falls. W. N. Baker, '15; D. L. Bellinger, '05; A. P. Davis, '14; C. B. Dix, '88; A. W. Harris, '97; J. C. Hemingway, '06; M. Hoopes, '91; F. R. Hyatt, '12; F. G. McRae, '02; R. K. Pratt, '13; R. N. Rausch, '13; C. F. Rhodes, '03; E. J. Trimbey, '05.
Glenfield. G. O. Littlefield, '11.
Gloversville. C. M. Bard, '13; A. A. Beattie, '75; G. M. Curtin, '13; G. W. Curtis, '12; W. F. Steele, '96; I. H. Wright, '09.
Glen Head. S. H. Townsend, '03.
Goshen. L. H. Downs, '09; G. C. Newbury, '06.
Green Island. J. T. McGinty, '03.
Glenham. L. S. Haskin, '02.
Greenport. A. A. Maynard, '15; F. J. Smith, '16.
Greenwich. W. Hill, Jr., '06.
Griffins Corners. O. H. Todd, '08.
Groton. N. Morton, '05.
Hamburg. W. Dallen, '06; E. C. Horton, '10; E. E. Kiger, '98; R. McCarty, '96; H. Seelback, '03; H. L. Sharp, '08.
Hague-on-Lake George. B. Thomas, Jr., '15.
Hawesville. A. N. Bannister, '12.
Hamilton. B. A. Hills, '11; S. Jones, '05; S. D. Smith, '72.
Hammondsport. C. S. Locke, '15; C. M. Younglove, '97.
Hastings-on-Hudson. O. A. Kenyon, '04.
Hempstead. N. T. Arms, '11; C. W. Carman, '97; L. P. Collins, '15; H. V. Cornwell, '13; W. F. McCullock, '95.
Herkimer. A. K. Osgood, '08; P. H. Quackenbush, '03.
Hicksville. F. D. Clark, '02.
Holcomb. W. G. Pope, '11.
Holland Patent. W. C. Robinson, '05; I. R. Thomson, '07.
Holley. B. M. Pettengill, '00.
Hornell. L. Hefter, '07; S. C. Hollands, '08; J. McDougall, '80.
Howes Cave. L. Casper, '05.
Hudson. F. O. Ebeling, '09; C. H. Evans, '13; K. E. Hildreth, '12; R. O. Holden, '11; P. Wood, '15.
Hurley. L. D. Lockwood, '16.
Huntington. D. M. Crossman, '10; G. Crossman, '10; E. C. Gillespie, '13.
Ilion. W. C. Dixon, F. Land, '91; W. A. Schmidt, '90.
Interlaken. J. B. Usher, '09.
Ithaca. C. D. Albert, '02; W. C. Ballard, Jr., '10; W. N. Barnard, '97; W. L. Bartholomew, '10; C. H. Berry, '12; A. G. Bierman, '08; E. G. Boring, '08; L. G. Bogart, '03; C. G. Brown, '14; H. W. Brown, '15; R. U. Brown, '15; H. G. Boynton, '15; R. C. Carpenter, '88; J B. Calkins, '16; W. G. Catlin, '10; J. B. Campbell, '11; G. R. Cessna, '93; G. R. Chamberlain, '91; R. F. Chamberlain, '08; D. Champaign, '13; J. A. Chater, '16; W. Y. Chim, '16; H. H. Clark, '15; B. L. Clymes, '13; H. Cole, '16; C. D. Corwin, '08; R. B. Day, '06; W. Deans, '13; O. H. Davis, '04; H. Diederichs, '97; W. J. Diederichs, '12; A. J. VanderDoes de Bye, '08; W. M. Driscoll, '88; P. T. Egbert, '15; F. O. Ellenwood, '04; W. S. Ford, '00; V. R. Gage, '06; V. G. Gahukin, '16; C. F. Haines, '08; C. W. Ham, '08; L. D. Hayes, '08; R. B. Hayes, '02; H. L. Haskin, '80; L. E. Hazen, '16; E. S. Holcombe, '01; A. G. Homan, '15; W. H. Hook, '08; H. F. Howarth, '09; J. Hurlburt, '05; T. O. Hussey, '12; E. T. Jones, '11; G. B. Kent, '10; F. E. Klinck, '10; W. H. Kniskern, '04; M. A. Lee, '09; G. N. Losee, '16; G. R. McDermott, '05; P. G. McVetty, '13; R. Mathews, '07; F. G. Merritt, '86; G. S. Moler, '75; W. E. Mordoff, '13; E. R. Morse, '15; R. V. Morse, '11; E. K. Muller, '97; J. L. Murphy, '92; G. B. Norris, '13; G. J. Noxon, '86; C. A. Pierce, '09; J. G. Pertsch, '09; J. F. Putnam, '10; H. M. Parmley, '07; R. L. Quick, '09; R. Rankin, '04; C. R. Reid, '16; J. E. Reyna, '99; H. W. Riley, '01; R. C. Rodgers, '05; F. S. Rogers, '13; G. M. Rogers, '13; L. C. Rumsey, '12; W. M. Sawdon, '08; H. M. Sharp, '15; W. B. Shays, '13; R. L. Shipman, '04; H. W. Sibert, '14; L. N. Siler, '15; A. W. Smith, '87; H. Stephenson, '07; F. L. St. John, '15; R. A. Steps, '11; A. C. Stevens, '07; F. G. Switzer, '14; F. G. Tappan, '07; C. E. Thomas, '13; J. W. Tourtellot, '92; J. C. Towmley, '07; C. E. Townsend, '07; R. H. Treman, '78; K. R. Trevor, '15; G. B. Upton, '05; H. T. Wallis, '13; E. T. Wallenbeck, '89; H. H. Walters, '13; P. Williams, '14; E. H. Woods, '92; F. Woodford, '09; A. B. Wray, '05; S. N. Bose, '17; A. B. Crandall, '17; P. L. Reymond, '17; R. T. Tree, '17; K. C. Tsang, '17; A. C. Woodward, '17; G. A. Worn, '17; H. M. Elmendorf, '17.
Islip. W. C. Haff, '12.
Jamaica. J. J. Ralph, '09.
Jamestown. F. P. Hall, '14.
Johnstown. C. P. Tymeson.
Kenwood. S. R. Leonard, '95.
Kingston. H. M. Linson, '99; J. R. Millard, '87; C. R. Stull, '07; E. M. R. Weiner, '06.
Kinderhook. A. O. Kellogg, '03.
Knowlesville. F. L. Hamilton, '08.
Lackawanna. H. C. Harding, '10.
Lacona. V. P. Corse, '95.
LaSalle. E. A. Kinsey, '00.
Lakeville. C. S. West, '05.
Laurel Hill. W. W. G. Rossiter, '11.
Lakewood. W. N. McComb, '92.
Larchmont Manor. C. W. Hall, '95.
Lake Placid. I. L. Stedman, '01.
Lestershire. G. P. Webster, '07.
Liberty. H. P. Tappey, '07.
Little Falls. C. D. Dalzell, '02; D. R. Mixsell, '10; H. J. Reed, '14.
Lockport. E. B. Carry, '00; G. W. Day, '01; L. O. Fanck, '98; W. J. Kline, '96; L. G. Merritt, '89; C. G. Peterson, '06; J. Richmond, '02; P. A. Richmond, '12; W. C. Shapleigh, '91; E. J. Wallower, '07.
Long Island City. N. R. Andrews, '04; F. C. Chapman, '07; E. P. Ramsey, '95; A. W. Morse, '08; L. Salmow, '14; T. C. Spates, '13; S. H. Woods, '06; H. W. Young, '15.
LeRoy. E. M. Scheu, '13.
Ludlowville. N. D. Howell, '10.
Lowman. G. J. Little, '16.
Lyons. F. L. Hoffman, '09; F. R. Killick, '11.
Malone. F. E. O'Neil, '07; E. E. Elder, '16.
Marcellus. W. L. Mulroy, '05.
Madison. C. E. Breckenridge, '00.
Maples. F. E. Sutton, '05.
Maspeth. E. W. Merrill, '93.
Marietta. H. C. Hotchkiss, '15.
Massena. R. C. Folger, '08; C. S. Thayer, '13.
Mecklenburg. A. T. Kelsey, '91.
Middleville. C. E. Dedicke, '12; B. P. Flory, '95.
Middletown. S. Dewsnap, '15.
Millbrook. C. C. Mitchell, '98.
Minetto. E. Diment, '09.
Mineola. L. R. Simons, '11.
Monticello. A. S. Owen, '10.
Morton. L. Storer, '08.
Mount Morris. J. M. Prophet, Jr., '10.
Mt. Vernon. E. A. Averill, '00; F. Bannerman, '99; A. L. Boegehold, '15; C. H. Chase, '08; F. A. Curtis, '97; J. M. Ferras, '16; H. N. Gildner, '07; B. P. Hermas, '05; W. G. Hicks, '10; W. E. Lindsay, '91; W. F. Lyle, '07; F. Miller, '06; A. Morse, '15; W. L. Reid, '09; H. W. Watt, '07.
Medina. F. G. Barlow, '13.
Mexico. W. G. Davis, '17.
Mohawk. R. C. Davis, '16; H. N. Scofield, '09.
Monroe. F. W. Maxstadt, '16.
Montour Falls. W. C. Cronk, '12; G. M. Layton, '02.
New Brighton. C. L. Barnum, '09; D. J. Gould, '09; A. E. Hart, '11; G. B Kable, '16; C. R. Scotti, '00; R. S. Watson, '11.
Newburgh. R. Beal, '00; E. C. Boynton, '87; J. R. Caldwell, '89; H. W. Cleveland, '08; A. M. Harkness, '05; H. A. Warden, '02.
Newfane. W. V. Brookins, '06.
Newfield. F. G. Snyder, '94.
New Rochelle. G. L. Carlisle, '00; A. S. Coble, '15; C. B. DuBoise, '02; C. G. Kingsley, '00; F. G. Pale, '17; W. T. Price, '06; W. R. Very, '13.
New York City. A. M. Acheson, '14; A. M. Acerman, T. D. Adams, '05; W. H. Adams, '09; F. F. Addicks, '13; W. E. Addicks, '14; H. H. Alcock, '96; C. G. Allen, '05; R. Allen, '13; P. W. Allison, '11; R. R. Allwork, '13; J. A. Almirall, '91; T. H. S. Andrews, '10; J. S. Anthony, '93; W. S. Appel, '08; G. F. Archer, '96; A. G. Armendariz, '11; A. R. Ayers, '00; G. W. Bacon, '92; N. Baehr, '12; R. L. Baggs, '09; C. E. Bailey, '96; E. F. Baker, '11; J. N. Baker, '05; R. L. Baker, '07; A. W. Baldwin, '12; J. M. Ballou, '15; P. A. Bancel, '00; C. R. Barney, '04; C. D. Barnhart, '05; J. H. Barr, '89; C. E. Barry, '96; J. V. Beam, '09; R. M. Bedell, '02; E. W. Bellinger, '11; G. H. Bayne, Jr., '04; W. P. Belknap, '95; R. W. Beardsley, '00; B. C. Bellows, '06; O. G. Bennett, Jr., '04; J. M. Benore, '16; C. W. Bergen, '00; F. H. Best, '11; V. L. Bevin, '10; S. Bevin, '08; R. K. Blanchard, '11; J. B. Blair, '99; J. B. Blunt, '05; F. W. Bein, '06; W. H. Boehm, '93; F. H. Boland, '93; H. C. Boos, '10; B. K. Boyce, Jr., '07; R. L. Boyer, '03; C. H. Blackburn, '15; A. D. Blake, '07; J. F. Booraem, '91; W. C. Boyrer, '92; A. P. Brady, '13; R. S. Brainerd, '13; W. S. Brayton, '93; J. E. Brewrink, '07; L. L. Brinsmaide, '97; E. F. Britton, Jr., '07; M. C. Brizse, '01; S. Breadwin, '13; R. H. Britton, '97; C. Brinckerhoff, '05; G. P. Brockway, '12; W. Brodie, '96; F. P. Bronson, '11; A. W. Brown, '96; G. T. Brown, '09; J. T. Brown, '76; P. G. Brown, '96; F. C. Bryan, '16; R. C. Bullard, '03; E. Burns, '03; F. S. Burns, '11; J. M. Burns, '10; A. Bruckner, '98; O. W. Brines, '02; E. G. Bruckman, '92; C. H. Brustlein, '99; H. A. Cahen, '16; E. Caldwell, '88; J. F. Callaghan, '12; C. F. Camp, '92; H. Cape, Jr., '13; C. E. Carpenter, '98; J. N. Carpenter, Jr., '14; D. B. Carson, '12; W. G. Carlton, '92; E. A. Carolan, '92; J. R. Cautley, '06; J. J. Cavaguaro, '00; P. G. Chace, '01; C. M. Chapman, '99; J. J. Chadwick, '16; N. C. Chambers, '05; C. F. Chapman, '05, E. H. Chapin, '89; R. E. Chapman, '11; G. E. Chase, '14; H. F. Chase, '96; H. Chase, '08; G. E. Chatillon, '01; H. W. Chatfield, '96; R. F. Chatillon, '01; L. D. Childs, '06; C. E. Chipman, '96; C. J. Christensen, '14; A. W. Church, '01; S. J. Chute, '13; M. E. Clark, '11; M. H. Clark, '99; M. W. Clephane, '93; J. A. Cleveland, '04; G. L. Cloran, '13; R. T. Close, '94; E. S. Cole, '94; I. E. Cole, '15; W. L. Colt, '94; G. W. Colton, '01; G. Comfort, '07; J. J. Connell, '97; F. D. Connor, '96; A. H. Cook, '98; F. A. Cook, '08; E. S. Cooley, '99; R. S. Cooper, '03; C. L. Cornell, '89; J. B. Cornell, '92; W. R. Couch, '02; A. Cowperthwait, '94; W. M. Craft, '94; A. G. Croll, '95; G. H. Craze, '10; R. L. Cullom, '15; O. P. Cummings, '94; T. P. Cunningham, '09; A. Curtis, '00; H. L. Curtis, '06; N. C. Cushing, '96; F. L. Danforth, '03; E. L. Davies, '07; J. P. Davies, '03; C. A. Dawley, '04; J. W. Day, '06; P. K. Dayton, '05; H. C. Defenbaugh, '06; O. De Lorenzi, '16; J. W. Desbecker, '06; A. W. DeRevere, '11; C. M. DeVed, '06; S. D. Dewsnap, '92; G. G. Dobson, '09; F. M. Dodge, '93; L. J. Doolittle, '93; W. H. Doran, '08; I. G. Downs, '01; A. G. Doyle, '12; M. M. Drake, '00; H. P. DuBois, '07; H. L. Duncan, '06; T. Earle, '06; L. Eidlitz, '77; J. M. Ellis, '77; H. F. Ely, '00; L. L. Emerson, '08; G. P. Engle, '09; H. Englehart, '13; C. F. Engle, '08; A. Englert, '00; C. W. Everson, '04; E. H. Faile, '06; M. C. Failor, '06; T. H. Fair, '96; A. Falkenau, '78; F. M. Farmer, '99; F. C. Farnsworth, '15; J. A. Ferguson, '07; G. B. Filbert, '12; R. N. Flint, '94; J. A. Florian, '93; C. A. Flynn, '05; J. R. Fry, '15; C. L. Funnell, '16; H. R. Gabay, '97; A. Gailey, '11; L. Gillet, '09; B. Gerhardi, '95; A. Glover, '08; W. E. Goldsborough, '92; E. Goldsmith, '94; M. S. Goldberg, '10; S. J. Goldwater, '04; F. F. Goodman, '90; R. L. Gordon, '95; N. A. Gorman, '16; C. A. Gould, '07; C. D. Gray, '00; F. R. Gray, '10; A. C. Grayson, '14; J. E. Greenawalt, '90; M. Greenberg, '06; G. D. Greene, '93; L. R. Grumman, '16; R. W. Gulick, '05; A. J. Haire, '05; J. Hamilton, '01; C. S. Hamner, '89; A. Harding, '97; H. G. Harris, '10; H. Harrison, '07; R. R. Harrison, '08; F. W. Hang, '08; G. V. Hartwell, '09; J. M. Hamilton, '94; E. A. Hawkins, A. T. Hayes, '14; N. A. Hanau, '16; H. T. Hardinge, '16; F. A. Halsey, '78; E. H. Harris, '15; R. H. Hazeltine, '99; S. M. Healey, '95; E. C. Heg, '10; F. W. Heitkamp, '97; H. H. Heller, '03; E. M. Henderson, '88; W. F. Hendry, '95; J. T. Hequembourg, '16; F. D. Herbert, '97; F. H. Hibbard, '14; H. L. Hibbard, '99; L. J. Hibbard, '04; B. A. Hildebrandt, '06; E. R. Hill, '93; R. Hineman, '11; J. F. Hoge, '06; D. L. Holbrook, '92; J. B. Holbrook, '96; B. A. Hollenbeck, '08; C. F. Horne, '97; R. Howe, '14; T. Howe, '96; G. L. Hoxie, '97; W. W. Hubbard, '97; A. J. Judson, '03; W. G. Hudson, '97; E. A. Hunger, '11; A. D. Hunt, '05; W. F. Hunt, '94; C. C. Hurlbut, '98; R. B. Hurlburt, '10; H. P. Hussey, '75; F. L. Hutchinson, '93; J. D. Ihlder, '87; W. M. Imbrie, '04; C. L. Inslee, '06; R. G. Inslee, '00; C. W. Isbell, '17; E. S. Isham, '90; A. J. Jacobs, '12; E. W. Janson, '07; H. Jawetz, '15; C. L. Jefery, '93; I. H. Jenney, '96; J. E. Johnson, '92; N. C. Johnson, '06; R. D. Johnson, '95; E. C. Johnston, '04; G. H. Jones, '12; T. M. Jones, '97; W. J. Jones, '99; J. A. Joseph, '08; J. M. Joy, '90; E. B. Katte, '94; M. L. Katzenstein, '02; W. Katzenstein, '03; W. Kelsey, '97; C. H. Kennedy, '12; S. B. Kent, '11; N. M. Kerr, '14; R. B. T. Killiani, '06; A. H. King, '15; H. B. Kirkup, L. Kissick, '06; M. M. Koch, '13; R. W. Krass, '06; G. O. Kuhlke, '14; F. Kuhne, '11; W. O. Kurtz, '05; S. D. Kutner, '11; W. B. Lachicotte, '92; C. D. Lally, '10; F. Lask, '04; A. M. Lamberton, '09; S. H. Langs, '15; C. J. Larson, '91; R. C. Latz, '15; E. B. Lefferts, C. D. Lefevre, '11; A. B. Levy, '90; L. H. Lewis, '97; D. A. DeLima, '95; R. R. Livingston, '01; E. M. Lloyd, '09; L. Levy, '91; C. D. Little, '05; F. V. D. Longacre, '97; C. A. Louis, '97; O. T. Louis, '97; R. S. Luce, '12; W. E. Lundgren, '14; F. L. Lucker, '09; L. Lindon, '96; J. V. McAdam, '00; M. R. McAdoo, Jr., '14; H. G. McDonald, '01; M. N. Maclaren, H. D. McFadden, '94; J. McGloan, '06; W. V. McGuinness, '16; L. McKendrick, '12; R. C. McKinney, '76; J. C. McCune, '07; M. P. McKay, '01; N. Macleod, '07; A. S. McAllister, '01; N. Macy, '94; J. D. Maguire, '98; S. G. Malby, '10; C. M. Manley, '98; A. B. Manny, '15; H. M. Marble, '93; L. B. Marks, '90; H. M. Mason, Jr., '08; J. B. Meinel, '09; I. K. Meltzer, '10; L. Middleditch, '05; B. H. Miller, '13; C. D. Miller, '10; O. G. Miller, '11; T. L. Miller, '10; J. J. Mintz, '07; F. M. Mitchell, '10; H. F. Mitler, '08; R. Mochiu, '15; H. E. Mole, '97; V. D. Moody, '00; J. H. Moore, '16; E. L. Morley, '92; W. A. Morgan, '05; J. L. Morgenthau, '11; R. W. Morrell, '09; G. H. Morris, Jr., '10; C. J. Morrison, '01; R. S. Mounce,

'09; F. D. Mullan, '97; E. C. Muller, '12; S. Mott, '11; W. C. Mumford, '12; R. F. Mundy, '04; T. Nakamigua, '14; A. Nathan, '88; P. M. Neave, '02; H. C. Nelson, '93; R. P. Nessler, '11; A. F. Niven, '11; H. H. Norris, '96; H. F. Northrop, '03; I. Norton, '05; F. J. Noyes, J. B. Odell, '04; M. H. Offinger, '99; M. W. Offutt, '03; H. G. Ogden, '97; J. N. Oliphant, '01; D. P. Orcutt, '07; W. D. Orvis, '07; L. A. Osborne, '02; P. M. Ott, '95; R. H. Overrocker, '11; D. B. Oviatt, '87; F. P. Palen, '94; J. Paret, '93; A. B. Park, '92; C. O. Pate, '00; R. S. Pattison, '05; R. S. Peck, '05; W. H. Peck, '89; F. E. Pendleton, '01; S. B. Perry, '94; H. C. Peters, '92; I. C. Petit, '03; E. L. Phillips, '95; R. E. Pierce, '13; S. C. Pinger, '05; H. M. Platt, '11; F. L. Pomeroy, '03; H. O. Pond, '96; H. K. Porter, '05; W. D. Potasky, '04; M. J. Powell, '14; H. M. Prest, '13; G. B. Preston, '97; L. C. Price, '11; F. L. Pruyn, '94; A. R. Purdy, '15; R. Raymond, '00; C. G. Rebman, '15; W. E. Reed, '89; N. S. Reeder, '96; D. F. Rees, '05; O. D. Reich, '12; F. Reinhardt; N. G. Reinicker, '11; C. C. Remsen, '01; R. B. Renver, '04; Y. Reyna, '97; H. B. Reynolds, '15; F. P. Rhane, '09; A. L. Richey, '11; W. T. Ricker, '96; H. H. Retter, '96; J. P. Ripley, '12; W. H. Ripley, '12; C. E. Rittenhouse, '08; E. W. Roberts, '74; C. R. Rockhill, '13; A. L. Rogers, '12; C. A. Rohr, '11; N. Romm, '13; L. D. Root, '08; M. C. Rorty, '96; D. Royse, '91; W. H. Rudolph, '12; J. E. Rutzler, '99; W. J. Ryan, '11; E. A. Ryder; S. S. Rose, '04; G. R. Sackman, '07; E. N. Sanderson, '87; W. B. Sanford, '01; H. W. Salsbury, '06; W. B. Schaefer, '98; A. T. Scharps, '07; R. Schoenijahn, '06; R. M. Schmid, '07; M. J. L. Schulte, '15; O. Segalowitz, '14; J. G. Serrell, '10; H. F. Sewall, '97; A. G. Seymour, '00; C. K. Seymour, '03; R. C. Seymour, '84; H. D. Shamberg, '12; A. R. Shaw, '10; J. H. Sheldon, '90; A. W. Shepard, '07; L. A. Shepard, '92; A. H. Sherwood, '01; W. P. Siebert, Jr., '13; J. B. Simontown, '06; W. J. Simpson, '07; B. A. Sinn, '97; H. W. Slauson, '07; W. G. Sloan, 99; B. C. Sloat, '02; C. C. Slocum, '07; F. S. Sly, '07; E. Smalley, '99; B. H. Smith, '03; I. W. Smith, '96; J. W. Smith, '93; L. G. Smith, '95; P. J. Smith, '95; R. A. Smith, '05; W. M. Smith, '98; C. Smithers, '96; R. J. Somerville, '12; E. L. Spencer, '96; W. M. Sperry, 2d, '12; E. D. Spicer, '12; F. D. Sprague, '07; B. C. Spransy, '14; E. P. Staats, '05; E. V. Stebbins, '94; W. C. Steele, '98; F. M. Stevens, '74; W. C. Stevens, '06; J. W. Stevenson, '01; W. M. Stevenson, '10; C. H. Stevick, '03; J. Samkoff, '14; O. L. Sands, '95; R. W. Sayles, '97; G. A. Schieren, '00; E. J. Schlesinger, '09; F. J. T. Stewart, '93; G. J. Stockley, '12; W. S. Stowell, '07; M. G. Stratton, '91; A. T. Strauch, '15; J. F. String, '16; H. C. Stroam, '12; R. H. Strother, '01; E. M. Sutcliffe, '93; J. J. Swann, '97; W. G. Swann, '99; R. L. Sweet, '06; G. P. Symonds, '93; A. B. Tappan, '01; J. P. Taylor, '04; R. S. Taylor, '12; T. B. Taylor, '00; S. J. Teller, F. Thomas, '10; J. E. Thomson, '11; U. Thompson, Jr., '14; H. F. Thurber, '90; C. E. Timmerman, '93; A. F. C. Toussaint, '14; F. B. Townsend, '08; P. Treager, Jr., '13; R. Trautschold, '02; A. C. Trego, '13; F. W. Trimble, '88; J. D. Turnbull, '11; J. B. Turner, '09; L. J. Turner, '02; J. H. Van Buren, '93; W. S. Valentine, '00; J. H. Van Buskirk, '93; A. C. VanderHoff, '11; A. C. Vanderpoll, '02; H. H. Van Fleet, '07; R. D. Van Valkenburg, '01; O. V. Vatet, '05; C. R. Vose, '14; K. Veit, '10; C. J. Walbran, '06; G. H. Walbridge, '90; L. B. Walbridge, '09; G. A. Wardlaw, '93; F. N. Waterman, '89; H. L. Waters, '00; H. D. Watson, '92; A. A. Watts, '94; F. C. Weber, '95; T. G. Weber, '10; R. W. Weed, '09; A. B. Weinberger, '14; E. C. Welsh, '05; S. B. Whinery, '99; H. H. Westinghouse, '75; J. D. White, '11; J. B. White, '99; R. W. White, '08; T. P. White, '04; J. H. Whitehead, '06; J. J. Whitty, '11; G. F. Wieser, '10; O. L. Williams, '88; J. I. Wile, '97; G. M. Williamson, '14; W. Willis, '98; C. Wineburgh, '04; F. I. Wise, '08; W. W. Wolff, '12; C. P. Wood, '04; O. A. Wood, '13; S. L. Wood, '93; J. A. Woods, '06; O. Wortmann, '06; B. G. Wray, '95; H. B. C. Wrenn, '96; J. C. Wright, '09; W. L. Wright, '00; W. B. Wrothe, '13; F. S. Yale, '03; T. S. Young, '15; W. S. Young, '90; W. C. Yenger, '04; S. Zuckerman, '09; M. S. Ayau, '17; A. F. Bancel, '17; L. W. Bartolicious, '17; J. Haydock, 3d, '17; E. L. Malone, '17; A. Salinger, '17; E. A. Sprong, Jr., '17; A. T. Strauch, '17; W. J. Wheeler, '17.

New York Mills. J. P. Campbell, '93.

New Brighton. T. E. Harper, '13.

Niagara Falls. W. L. Bliss, '93; L. H. Colpoys, '15; W. B. Cornell, '07; C. C. Eghert, '95; R. D. Glennie, '08; W. Hapgood, '08; O. B. Hastings, '10; T. L. Harper, '97; C. Highland, '09; E. P. Hinds, '96; T. L. B. Lyster, '03; C. A. Mudge, '97; A. A. Richardson, '08; J. W. Schwarz, '07; G. R. Shepard, '96; E. C. Speiden, '04; F. J. Tone, '01; J. W. Trott, '08; C. A. Tryon, '01; F. F. Tschabold, '05; J. F. Wait, '16; A. U. Wetherbee, '08.

Nichols. W. F. DeGroat, '17.

Norwich. L. L. Skinner, '09.

Norwood. R. E. Clark, '13.

North Salem. G. M. Howe, '94.

North Tonawanda. S. L. Petrie, '09; B. C. Rand, '03; E. O. Spillman, '97.

Nyack. L. M. Wilson, '94; R. G. Wightman, '16.

Oak Summit. R. H. Mitchell, '76.

Oakfield. J. R. Davis, '15.

Odessa. F. T. Estabrook, '16.

Ogdensburg. E. Clark, '11; M. J. Miller, '13; J. P. Seymour, '92; R. Tallman, '96; C. R. Westbrook, '13.

Olean. E. Atwood, '11; E. M. Johnson, '06; J. B. Johnson, '12; G. W. Luther, '05; L. E. Mallery, '08; E. F. Mason, '05; W. K. Page, '09; H. S. Ritter, '11; C. S. Smith, '07.

Oneonta. M. W. Clough, '13; J. B. Lane, '11; E. G. Place, '11.

Oneida. S. L. Chapin, '17; P. B. Herrick, '96.

Orchard Park. G. C. Willey, '11.

Ossining. J. H. Morgan, '10; E. C. M. Stahl, '13; E. R. Acker, '17; H. C. Pierson, '11.

Oswego. R. I. Brewer, '14; J. O'Connor, '07; C. Morrison, '05; H. K. Peebles, '16; A. W. Poucher, '84.

Owego. S. K. Eastwood, '13; T. H. Farrington, '10; H. L. Mallery, '15; F. D. Martin, '15.; A. D. Young, '05.

Oriskany. J. E. Waterbury, '10.

Ovid. C. H. Kinne, '12.

Oyster Bay. H. W. Ludlam, '92; W. L. Swan, '04.

Oxford. L. C. Beadle, '08.

Painted Post. C. L. Cook, '15; J. A. Sanford, '15; D. H. Seeley, '13.

Patchogue. F. M. Hammond, '17.

Peekskill. H. J. Martin, '11; W. F. Orleman, '08.

Pelham. J. M. Ferris, '16; N. C. Robbins, '94.

Penns Grove. G. P. McNear, '13.

Penn Yan. C. R. Andrews, '08; H. L. Parsons, '10; H. M. Short, '08; M. Tracy, '09; R. Winship, '11.

Peruville. G. Darling, '74.

Perry. R. C. Parker, '08.

Pike. L. H. Lathrop, '15.

Phoenix. H. W. Sweet, '04.

Pittsford. S. F. Crump.

Plattsburg. H. H. Bromley, '09; J. A. Haggerty, '01; E. A. Turner, '01.

Pleasantville. J. D. Curtis, '96.

Potsdam. H. E. Worden, '08.

Port Henry. J. G. Witherbee, '90.

Port Chester. E. Burdsall, '78.

Port Jervis. W. K. Lain, '89; R. W. Rogers, '04; D. R. Thomas, '01.

Port Richmond. F. G. Burger, '07; L. H. de Leon, '05; A. C. Liverton, '96.

Portland Point. H. W. Goodier, '16.

Poughkeepsie. W. Church, '85; S. H. Hall, '03; L. A. Krum, '96; J. E. Nelson, '10; M. S. Parkhill, '17; H. H. Vail, '10; H. H. Van Cleef, '93; P. A. H. Weiss, '16.

Pulaski. M. B. Huntington, '17.

Quoque. G. P. Jessup, '08.

Randolph. L. A. Rice, '01; G. C. Salisbury, '12.

Red Creek. G. G. Wood, '94; M. L. Whitney, '97.

Ridgefield Park. C. G. Blake, '14.

Richmond Hill. L. Boblker, '08; A. K. Hobby, '13.

Riverhead. J. R. Terry, '11.

Rockland. C. B. Palen, '13.

Rochester. C. A. Alexander, '97; J. B. Allington, '14; P. L. Arnold, '07; E. G. Ashley, '94; E. S. Atwood, '03; W. S. Austin, '96; J. S. Avery, '99; C. E. Bahn, '16; D. L. Bentley, '07; G. F. Benson, '09; O. W. Bodler, '01; G. W. Booth, '81; I. E. Booth, '83; H. B. Brewster, '98; C. B. Carson, '09; G. D. Collier, '06; G. J. Couch, '06; E. H. Cumpston, '09; F. H. Damon, '08; H. W. Davidson, '01; W. F. Devendorf, '98; L. A. Dunbar, '14; E. G. Eldredge, '12; M. C. Ernsberger, '08; J. A. Fish, '12; A. C. Gleason, '97; W. F. Goff, '09; J. F. Hitchcock, '07; H. L. Howe, '10; R. S. Humburch, '09; W. C. Johnston, '09; C. H. Keller, '15; J. E. Kittrell, '15; G. Lawson, '06; B. L. Madden, '08; G. C. Meyer, '17; B. Meyering, '15; R. L. Morris, '17; E. V. Patterson, '12; A. M. Phillips, '04; W. E. Pratt, '14; J. K. Rewalt, '11; R. W. Robbins, '01; R. M. Robinson, '12; D. C. Rockwood, '99; R. C. Schwarz, '08; G. O. Smith, '03; C. T. Somerly, '13; I. Stern, '97; A. L. Stewart, '09; A. Stuber, '12; L. J. Sullivan, '13; L. B. Swift, '12; F. K. Taylor, '09; A. R. Teal, '00; S. G. Thayer, '03; R. T. Tree, '13; C. L. Tuttle, '04; H. E. Van Derhoef, '01; M. S. Van Vleet, '04; J. W. Ward, '13; M. W. Wiesner, '16; H. G. White, '93; P. S. Wilcox, '97; E. L. Wilder, '02; P. Will, '00; K. O. Wolcott, '07; H. C. Woodbridge, '97; R. H. Woods, '13.

Rome. W. T. Binks, Jr., '17; J. Dean, '07; H. T. Dyett, '97; J. P. Halstead, '08; C. E. Plunkett, '15; J. S. Wardwell, '15; J. Wechsler, '07.

Rondout. O. R. Hilterbrant, '08.

Rockville Center. W. L. Merry, '15.

Rock Stream. J. B. Tinker, '99.

Roscoe. E. F. Watson, '14.

Rutherford. E. P. Van Mater, '97.

Saratoga. C. H. Parmelee, '13.

Saratoga Springs. E. B. Hammond, '01; T. H. Latimer.

Sable Forks. H. G. Rogers, '01.

Schenectady. S. H. Abbey, '09; J. R. Blakeslee, '02; H. D. Brown, '10; J. S. Button, '96; J. D. Buchannan, '09; C. Clark, '08; C. S. Coggeshall, '11; J. R. Craighead, '06; T. E. Davis, '13; W. J. Day, '97; W. V. DeLano, '98; H. A. DeWitt, '09; W. C. Durent, '04; W. N. Eddy, '16; W. G. Ely, '92; O. Erisman, '97; H. C. Fairbank, '05; N. G. Golden, '17; E. J. Gregson, '06; C. L. Heisler, '90; E. B. Holden, '94; R. J. Johnston, '12; C. A. Kelsey, '01; A. Kennedy, Jr., '07; E. M. Kenney, '99; E. C. Knapp, '90; C. B. Larzelere, '97; W. D. Laurie, '15; H. M. Lewis, '09; W. B. Lindsay, '08; C. Y. Lo, '13; A. D. Lunt, '92; J. J. Matson, '15; S. R. Morgan, '16; A. Mulford, '15; H. B. Murray, '16; S. P. Nixdorf, '10; C. R. Osborne, '03; H. C. Pease, '97; H. W. Peck, '00; E. Place, '94; C. G. Rally, '02; L. W. Riggs, '10; M. A. Rusher, '10; D. B. Rushmore, '95; R. H. Russell, '13; J. A. Sanford, '16; L. H. Schenk, '00; B. F. Starr, '11; W. G. Taylor, '07; W. H. Treene, '10; C. L. Turner, '13; J. W. Upp, '89; F. M. Van Zill, '06; F. West, '04; E. J. Wiederhold, '06; H. N. Williams, '12; W. E. Woodward, '96.

Scarsdale. H. S. Otto, '07.

Scio. R. G. Babcock. '15.

Scottsville. L. M. Slocum, '11.

Seneca Falls. W. G. Allen, '04; N. J. Gould, '99; S. S. Gould, Jr., '11; H. D. Hadley, '11; C. M. Klepser, '11; C. K. Lewis, '12; A. V. Polson, '17; W. D. Pomeroy, '96; W. H. Titus, '05.

Seneca. H. E. Haslett, '06.

Sharpsville. F. W. Pierce, '04.

Shortsville. F. A. Titus, '91.

Silver Creek. T. H. Cowdin, '00.

Sodus. G. D. Hulett, '91.

Schoharie. B. Stevens, '97.

Southampton. W. P. Nugent, '16.

South Easton. P. D. Ives, '90.

South Byron. W. L. Trick, '85.

Spencer. C. A. Seeley, '04.

Spring Valley. L. A. Tallman,

Stapleton. C. W. Badenhausen, '17; C. W. Hunt, Jr., '12; H. E. Mecke, '11.

St. Johnsville. F. A. Klock, '02.

Staten Island. M. M. Wiechers, '16.

Stony Hook. H. L. Rogers, '08.

Syracuse. W. K. Archbold, '89; C. G. Baldwin, '17; E. A. Barnes, '09; G. W. Barnes, '94; J. H. Barr, '13; R. H. Bennett, '95; E. R. Blinn, '12; J. P. Boardman, '76; R. I. Brewer, '17; C. S. Brown, '12; G. H. Brown, '94; G. N. Brown, '05; H. W. Brown, '11; W. C. Brown, '81; W. Brown, '17; E. S. Bundy, '11; B. S. Burlingame, '03; R. B. Chapman,'78; H. J. Clark, '95; H. N. Craner, '02; J. L. Crouse, '05; F. E. Cuddeback, '05; L. E. Dale, '12; H. G. Daboll, '03; D. H. Dew, '15; H. Edwards, '14; W. W. Edwards, '93; A. R. Gillis, '75; C. E. Gowdy, '11; E. C. Hagar, 95; K. G. Haxtan, '10; F. Heermans, '78; C. M. Jackson, '12; E. W. King, '97; F. B. Klock, '99; G. M. Kohler, '02; W. E. Lape, '77; J. F. Lardner, Jr., '15; H. J. Leighton, '81; K. Leighton, '17; A. V. Lindsley, '09; C. D. McLaughlin, '12; W. S. Manning, '95; K. D. Means, '13; M. S. Melville, '12; J. D. Mickle, '93; C. E. Montague, '09; D. F. Morss, '11; W. C. Pearce, '97; T. E. Pennock, '10; H. W. Pease, '09; F. Pillmore, '92; H. D. Pomeroy, 90; J. H. Schaefer, '07; G. H. Shepard, '02; E. L. Smith, '17; D. R. Spier, '00; B. L. Thompson, '03; W. J. Thorne, '11; S. J. Titus, '06; L. S. Tracy, '98; C. C. Trump, '11; J. L. Wagner, '95; J. Wilkinson, '89; G. B. Woodle, '15; G. A. Young, '13; D. Younglove, '12; E. W. Zimmerman, '07.

Suffern. F. B. Hoagland, '05; A. T. Lockard, '12.

Tarrytown. K. F. Carter, '12; E. J. Maxwell, '14; F. M. Whyte, '80.

Tenafly. C. R. Sanderson, '95.

Tompkinsville. F. A. Postel, '08.

Tonawanda. D. S. Bellinger, '02; W. W. Faulkner, '94; K. J. Litchka, '09; W. W. Robertson, Jr., '17; S. E. Shaw, '15; L. D. Simson, '11.

Troy. F. Harrison, '94; W. J. Kemp, '01; S. Knight, '99; C. Lessels, '02; H. H. McClellan, '97; F. W. J. McKilben, '98; H. H. Shires, '08; J. J. Starkweather, '96; C. H. Stillman, '96; C. I. Warren, '05.

Trumansburg. I. Buys, '17; J. H. Godfrey, '95; J. S. Hoffmire, '16; E. L. Pierson, '17; E. L. Young, '13.

Unadilla. M. D. Gregory, '09.

Union. W. H. Dickerson, '99.

Upper Troy. H. E. Johnston, '02; H. S. Marks, '07.

Utica. G. P. Adams, '15; G. T. Ballard, '02; M. H. Bicklehaupt, '03; W. J. Childs, '01; S. S. Curran, '94; H. E. Davis, '09; C. D. Damsky, '17; C. J. Gomph, '02; A. R. Hatfield, '97; W. W. Kirley, '91; H. V. Owens, '05; P. A. Schenck, '07; L. D. Speed, '05; J. L. Stone, '16; M. W. Strong, '01; H. B. Sweet, '94.

Union. F. L. Barton, '07.

Valatie. W. C. Dalzell, '00; J. L. Landt, '14.

Valley Falls. N. Esmond, '08.

Valley Stream. F. C. Gobel, '03.

Warsaw. A. H. Bligh, '09.

Waterford. J. Knickerbocker, '87.
Waterloo. A. H. Bigelow, '09; H. A. Yost, '10.
Wantagh. H. L. Seamon, '09.
Watertown. W. B. Ball, '13; F. H. Inglehart, '02; C. W. Palmiter, '14; T. F. I. Tomlines, '17.
Washingtonville. C. N. Glover, '05.
Waverly. S. Baldwin, '92; J. R. Tozer, '15.
Watervliet. G. S. Edmunds, '95.
Wellsville. C. P. Clark, '11; C. J. Tehle, '14.
Westbury. F. S. Loughlin, '15.
West Milton. C. A. Clute, '89.
West Bloomfield. R. E. Hopkins, '12.
West New Brighton. C. M. Cortelyou, '06; G. B. Edgar, '16; J. R. Haviland, '16.
West Winfield. W. N. Bardius, '99.
Westchester. J. M. Butler, '96.
Whitesboro. E. H. Warner, '94; C. W. Waterbury, '02.
White Plains. J. Henderson, '72; J. H. Schnepel, '95.
Wiscoy. R. I. Davidson, '99.
Wisner. C. M. Houston, '17.
Woodmere. A. Josephy, '08.
Woodside. T. Johnson, Jr., '12.
Woodhaven. W. E. Krieg, '15; R. F. Luce, '17.
Wolcott. R. S. Cooper, '13.
Willseyville. H. M. Strong, '17.
Yorktown Heights. S. S. Horton, '14.
Yonkers. C. D. Bloomer, '03; H. B. Cushman, '16; G. R. Douglas, '14; C. Eickmeyer, '91; C. B. Howe, '93; W. J. Koster, '06; R. L. Krouse, H. G. McMillan, '07; F. W. Midgley, '08; A. L. Nachman, '05; J. S. Piper, G. N. Rigly, '95; H. L. Rossire, '08; C. R. Runyon, '14; W. L. Saunders, '99; P. L. Scott, '15; F. J. Shannon, '10; W. R. Simpson, '93; H. A. Skinner, '10· W. K. Sowdon, '11; J. B. Tiffany, '78; O. S. Tyson, '10; J. H. Van Deventer, '03.

NORTH CAROLINA

Ashville. B. F. Bernard, '12.
Bradin. F. W. Buck, '09.
Canton. B. C. Hope, '13.
Charlotte. E. S. Alexander, '13; D. Clark, '98; W. M. Cowles, '13.
Concord. W. G. Broadfoot, '12.
Burnsville. C. W. Harper, '12.
Edenton. M. Makely, Jr., '07.
Goldsboro. A. C. Davis, Jr., '14; G. S. Dewey, '05; T. A. Dewey, '06.
Greensboro. M. W. Thompson, '95.
Hall River. J. W. McPherson, '16.
High Point. E. A. Snow, '73.
Kenansville. J. W. Farrior, '07.
Monroe. B. F. Lownsberg, '12.
Oakwoods. H. H. Morehouse, '89.
Penland. S. G. Giles, '12.
Raleigh. W. T. Andrews, '94.
Wilmington. W. W. Storm, '07.

NORTH DAKOTA

Balfour. E. W. Meinhardt, '96.
Corrington. R. W. Graham, '15.
Grand Forks. C. H. Crouch, '92.
Minot. F. Curtis, '76; B. R. Du Ball, '12.

OHIO

Akron. E. H. Baker, '16; T. A. Bennett, '97; A. A. Brewster, '04; S. J. Ferbstein, '13; H. H. Graaf, '16; F. C. Howland, '03; A. C. Johnson, '12; A. Hale, '16; J. T. Johnson, Jr., '09; R. N. Johnston, '11; A. H. Leavitt, '09; M. D. McMaster, '16; R. McClenathen, '97; B. G. Merrill, '03; W. R. Miller, '99; R. G. Nevins, '12; F. W. Pierce, '16; A. S. Ridgeway, '16; C. J. Roese, '16; V. R. Reed, '13; J. A. Schotta, '12; R. Saalfield, '15; L. O. Vesser, '03; G. Norwood, '98; R. E. Keefe, '17; R. M. Watt, '17.
Ashtabula. S. T. Harris, '11.
Barberton. W. A. Smith, '03.
Bradford. R. H. Flinn, '09.
Briggsdale. H. M. Bush, '93.
Canton. C. M. Berger, '93; H. E. Cavnah, '01; H. Correll, '07; G. H. Bockins, '17; W. A. Harris, '93; D. D. Miller, '06; H. Van Derbeek, '94.
Chillicothe. J. R. Bolgiano, '09.
Cincinnati. T. S. Berna, '12; W. Bohrer, '06; J. R. Cameron, '09; A. O. Daller, '12; A. G. Drury, '07; W. G. Ebersole, '13; K. S. Edwards, '10; H. Epstein, '11; F. C. Fabel, '96; W. M. Goldsmith, '09; M. A. Grambow, '12; O. E. Hilmer, '07; C. B. Hoffman, '11; L. F. Hobart, '13; F. H. Holz, '02; C. E. Johnson, '04; F. P. Johnson, '96; S. C. Kriebel, '94; J. F. Luhrman, '09; R. K. Livingston, '16; A. Marx, '03; H. Mara, '79; M. B. McDermott, '17; J. L. Mitchell, '11; J. Morrison, '94; C. C. Myers, '05; R. Poppenheimer, '12; S. G. Pollard, '91; A. C. Pounsford, '13; G. W. Rosenthal, '13; W. C. Rosenthal, '11; S. F. Rice, '07; E. W. Roberts, '95; W. H. Rastall, '04; E. Schlemmer, '03; R. T. Skinner, Jr., '11; J. J. Springer, '03; A. W. Walton, '11; G. W. Walker, '04; A. G. Wessling, '93; R. M. Wilderberg, '15; H. M. Wood, '04; C. R. Wylie, '05; F. Steinwehr, '07; R. E. Greuter, '17.
Cleveland. W. H. Aldrich, '04; E. R. Alexander, '01; W. Ambler, '00; F. G. Anderson, '06; M. V. Bailliere, '07; F. W. Ballard, '96; J. F. Barker, '93; L. R. Berkeley, '07; M. R. Berry, '03; J. C. Barker, '12; W. D. Becker, '13; H. D. Blake, '09; A. Bonney, Jr., '12; H. A. Blythe, '92; K. E. Britton, '06; A. Bradley, '07; W. H. Brown, '93; E. P. Burrell, '99; G. F. Burrows, '00; H. D. Campbell, '98; C. D. Carlson, '08; G. Carpenter, '06; F. M. Case, '99; A. S. Clarke, '08; T. P. Clay, '10; T. J. Calhoun, '08; R. H. Cleminshaw, '16; D. S. Cole, '12; E. Cowles, '16; R. R. Coleman, '12; R. T. Cloyes, '10; E. S. Curtiss, '06; F. D. Davis, '90; C. H. Day, '04; R. Deming, '00; H. M. Diemer, '03; H. Dingle, '05; L. S. Douglass, '10; G. B. Dusinberre, '86; D. Gaehr, '01; R. L. Eastman, '14; A. B. Gould, '00; R. D. Grant, '03; M. S. Haas, '02; J. N. Halle, '07; A. S. Hatch, '16; H. S. Hawkins, '11; D. S. Hayes, '06; L. H. Hayes, '98; C. J. Herbould, '10; H. H. Hill, '97; J. D. Hill, Jr., '94; J. W. Holt, '08; F. L. Hornickel, '15; E. C. Henn, '15; J. L. Howe, '08; R. G. Hubbey, '93; T. B. Hyde, '08; H. Konyonmdjian, '06; C. W. Kelly, '81; B. P. Kinney, '01; W. G. Kranz, '94; L. H. Loomis, '06; H. W. Lormor, '13; C. Marcus, '10; J. R. Massey, '93; A. B. McNairy, '72; S. A. Meddaugh, '04; R. G. Miller, '11; R. R. Nickerson, '07; B. A. Miller, '95; C. Mongtomery, '12; H. D. North, '07; C. H. Owen, '07; O. Payne, '94; C. E. Pope, '91; H. R. Palmer, '87; H. Pinney, '15; G. W. Pope, '98; H. B. Prother, '90; R. W. Proctor, '12; V. B. Phillips, '15; R. L. Rathbone, '98; W. B. Rawson, '01; H. P. Reighardt, '08; T. W. Rolph, '07; H. K. Rice, '92; W. C. Runyan, '08; W. C. Sayle, '10; E. J. Schroeter, '14; A. R. Schiele, '11; W. H. Senior, '04; T. K. Senior, '11; E. B. Simpson, '94; S. C. Smithers, '10; W. G. Snider, '06; C. H. Strong, '93; J. G. Strong, '06; H. F. Stratton, F. H. Teagle, '02; B. R. Tewksbury, '11; L. B. Timmerman, '14; F. S. Tuerk, '07; J. A. Webb, '09; L. M. Uhl, '11; S. A. Vail, '10; C. Van Blarcom, '08; T. B. Van Dorn, '92; S. K. Wellman, '14; H. G. Wellman, '05; L. H. Wallace, '06; C. W. Wason, '76; A. C. Watkins, '15; C. W. Webb, '02; H. W. Wiley, '16; H. G. Weidenthal, '13; G. Wilson, '05; O. R. Wilson, '95; W. T. Woodrow, '15; C. F. White, '05; R. H. White, '94; L. R. Wosika, '05; R. H. Wright, '09; H. P. Boggis, '17; A. S. Hatch, '17; W. G. King, '17.
Columbus. W. J. Armstrong, '05; B. H. Brooks, '97; C. W. Brown, '12; F. C. Caldwell, '91; E. W. Campion, '06; A. E. Flowers, '02; E. A. Hitchcock, '90; T. T. Hubbard, '95; G. T. Johnson, '06; J. B. Lanman, '16; W. H. Lanman, '95; H. Maxwell, '05; R. A. McConnell, '10; L. H. Spear, '90; J. J. Walsh, '98; L. R. Yeager, '13.
Coshocton. P. H. Haselton, '15.
Cuyahoga Falls. L. A. Vaughn, '09.
Dayton. J. F. Hemberger, '09; G. H. Kramer, '02; J. F. Ohmer, Jr., '13; C. A. Paullin, '13; E. T. Turner, '10; F. H. Tyler, '13; H. C. Wight, '09.
Defiance. A. T. Wood, '02.
East Liverpool. H. D. Brookman, '09.
Elyria. J. P. Brooks, '10; C. C. Farkell, '92; S. E. Hitt, '91; M. E. Roe, '04; W. H. Thomas, '04; W. E. Gray, '87.
Fremont. H. Zimmerman, '95.
Geneva. W. R. Ellis, '03; C. H. Russell, '04.
Glendale. R. F. Rogan, '97.
Hamilton. T. S. Goodman, '08; G. M. Goldsmith, '05; M. A. Hartwig, '05; A. M. Kahn, '09; H. G. Mosler, '10; E. T. Pfau, '12; M. B. Pfau, '10; G. G. Terriberry, '15; J. E. Ward, '14; A. Wood, '91.
Hillsboro. B. M. Boyd, '03.
Hudson. C. F. Turner, '91.
Huntsburg. W. W. King, '77.
Ironton. F. G. Schlosser, '89.
Kent. C. S. Van Deusen, '94.
Lakeside. C. F. Lake, Jr., '96; B. A. Smith, '17.
Lakewood. H. J. Smith, '93; G. A. Gilmore, '16
Leetonia. O. G. Kearney, '12; S. S. Shields, '93.
Lima. H. T. Beckman, '09; L. C. Welch, '06.
Lorain. E. L. Upp, '93.
Mansfield. C. T. Anderson, '05; H. H. Elmendorf, '14; R. M. Johnson, '05; C. A. Miller, '11; G. H. Patterson, '07; G. W. Rice, '06; C. Yahn, '14; M. Schiff, '12.
Massilon. R. H. Bahney, '17; F. C. Snyder, '06.
Marblehead. G. W. Lapp, '07.
Marion. W. P. McKinney, '15; T. L. McMurray, '14.
Martins Ferry. C. E. Lipphardt, '03.
Medina. S. C. Shephard, '93.
Middletown R. A. Shartle, '92; C. W. Verity, '11.
Mt. Vernon. A. T. Waight, '08.
Newark. M. A. Ankele, '09; J. E. Currie, '08.
Norwalk. J. Comesky, '93.
North Industry. C. A. Sewa, '93.
Oberlin. G. T. Street, '03.
Painesville. E. P. King, '01.
Palestine. M. W. Roe, '96.
Portsmouth. W. G. Moorman, '08; C. L. Turley, '14; J. D. Williams, '13.
Port Clinton. J. H. Wells, '03.
Ravena. H. C. Beckwith, '03.
Salem. F. J. Emeny, '95; C. S. Bonsall, '79.
Sandusky. T. H. Savery, Jr., '96.
Springfield. L. P. Kalb, '10; F. W. Smith, '08; A. C. Taylor, '95; F. W. Walsh, '95; R. H. Kipp, '03; J. L. Webb, '09; E. S. Corcoran, '17.
Steubenville. H. B. Conover, '07; J. B. Hammond, '11; G. W. Vreeland, '98.
Tiffin. H. E. Epley, '03; R. R. Krammes, '09; M. Raymond, '11.
Toledo. J. M. Acklin, '06; S. D. Bullock, '99; F. J. Baur, '06; V. B. Chase, '16; W. A. Clarke, '92; F. C. Corey, '13; A. B. Morrison, '01; C. W. McKinley, '11; I. E. Macomber, '94; O. H. Paddock, '07; E. Rathbun, '97; S. J. Rathbun, '95; D. F. Smith, '13; W. E. Schroeder, '94; C. F. Souder, Jr., '16.
Urbana. R. W. Kirby, '93.
Wellsville. P. S. Menough, '07.
Wilberforce. G. R. Tompkins, '10.
Willoughby. J. A. Beidler, '03; S. G. Brown, '99.
Warren. W. Packard, '14; H. J. Raymond, '10; H. E. Stewart, '09.
Worthington. T. Midgely, Jr., '11.
Xenia. H. S. Bailey, '08.
Youngstown. R. D. Day, '06; J. Davidson, Jr., '09; H. A. Boyd, '96, A. A. Lane, '01; M. Evans, '14; R. C. Shook, '07; L. T. Wick, '12; J. P. Young, '97.

OKLAHOMA

Chelsea. P. W. Phillips, '07.
Norman. L. W. W. Morrow, '11.
Perry. J. C. Lyddon, '11.
Stillwater. R. E. Chandler, '97; E. J. Kuntze, '01.
Tulsa. S. W. Collins, '13; G. E. Edgett, '04; A. G. Heggem, '97; R. W. Hendee, '17; D. R. McDonnell, '14.

OREGON

Coos Bay. G. R. Sailor, '07.
Corvallis. G. A. Covell, '87; R. H. Dearborn, '00; R. Steelquist, '10.
Creswell. F. H. Swift, '11.
Grants Pass. J. B. Paddock, '74.
Hillsboro. T. Bilyeu, '07.
LaGrande. W. Eckley, '17.
Medford. W. F. Brown, '93; F. L. Hoppin, '07.
Parkdale. R. E. Babson, '06.
Pendleton. F. L. Fairbanks, '10.
Portland. H. P. Buckner, '13; J. C. Burkhart, '08; J. G. Clemson, '03; C. E. Cleveland, '11; O. B. Coldwell, '02; W. R. Cornell, '13; W. B. Gleason, '11; W. T. Harrison, '07; R. D. Hoyt, '03; W. H. Lines, '09; F. R. McBride, '13; A. M. Mears, '10; C. D. Monteith, '12; M. B. Moores, '07; J. C. Othus, '17; L. Rosenstein, '09; H. C. Smith, '03; C. E. Warner, '92; J. W. Watzek, '14; C. L. Wernicke, '03; H. W. Wessinger, '10; F. W. Wood.
Ranier. G. H. Thayer, '90.
Roseburg. S. W. Andrews, '12.
Salem. C. W. Brown, '07; L. W. Metzger, '09; W. Van Winkle, '07.
Yonkalla. J. G. Miller, '14.

PENNSYLVANIA

Allentown. C. L. Beckwith, '15; T. W. Milnor, '89; F. Sheldon, '11; W. D. Wood, '09.
Altoona. J. B. Collin, '06; H. Flood, Jr., '09; E. P. Jagard, '17; G. M. Nauss, '07; L. M. Ryan, '98; J. Slutzker, '08; L. Plack, '91; C. D. Young, '02.
Annville. A. R. Kreider, '93.
Antrim. W. J. Howell, '10.
Ardmore. R. D. Donaldson, '07; A. Knapp, '07; I. W. Knapp, '75; P. Knapp, '17; I. W. Knapp, '75.
Athens. F. R. Ahbe, '07; H. R. Andrews, '13; C. F. Kellog, '97; P. F. Page, '04; J. F. Sturrock, '13.
Atlanta. A. E. Werner, '98.
Avalon. H. B. Hukill, '16.
Bear Lake. F. E. Bonsteel, '96.
Beaver Falls. L. L. Bentley, '90.
Beaver. S. N. Craig, '06; J. M. Eaton, '10; E. Burgher, '12.
Bellevue. N. L. Shaw, '05; M. Sleeth, '06; R. E. Best, '08; L. A. Ebaugh, '17.

Bellefonte. H. F. Whiting, '94.
Berwick. C. G. Crispin, '02; A. T. Lowry, '07; T. W. Sheffer, '08.
Bethlehem. G. J. Costello, '03; W. W. Pickslay, '15; W. H. Stocking, '15.
Bradford. H. M. Jacks, '06; C. L. Melvin, '06; J. W. Stewart, '14.
Butler. J. S. Campbell, '12; G. E. Howard, '93; P. S. Peck, '08; J. G. Rowe, '14; R. L. Spaide, '08.
Braddock. W. H. Cosgrove, '15; L. R. James, '03.
Carbondale. J. W. Aitken, Jr., '08.
Carlisle. W. T. Janney, '01.
Catasauqua. A. L. Broadhead, '95; H. H. McHose, '14; M. M. McHose, '14; J. R. Thomas, '07.
Chambersburg. C. M. Wood, '07.
Chester. J. L. Wetherill, '07; W. M. White, '08; A. C. Vail, '16.
Clairton. W. P. Chandler, Jr., '10.
Clearfield. E. L. Peterson, '10.
Coatesville. H. Blackwell, '12; R. E. Curtis, '14; J. W. H. Martin, '17.
Cochranton. R. C. Curtis, '07.
Columbia. A. H. Meyers, '91.
Coraopolis. H. G. White, '00.
Corry. E. J. Lewis, '99; C. R. Rogers, '07; S. V. Stewart, '07.
Crafton. H. P. Reiber, '08; C. A. Schaedle, '07.
Cynwyd. H. M. Coale, '04; H. E. Sibson, '03; D. B. Spanogle, '07.
Danville. P. E. Paules, '15; P. A. Vannan, '08.
DuBoise. J. Blakeslee, '06; R. B. Blakeslee, '99; T. M. Bruback, '12; M. E. Ginter, '07.
Duquesne. E. F. Entwisle, '06; K. C. McKutcheon, '15.
East Liberty. R. T. McKnew, '10; H. S. Yundt, '09.
Easton. W. S. Stotoff, '97; W. A. Tydeman, '03.
East Pittsburgh. C. B. Auell, '92; R. A. Bolze, '10; C. S. Burlingham, '14; C. S. Coler, '11; E. P. Gooch, '14; J. S. Green, '96; B. M. Hen, '06; W. M. McConahey, '93; F. D. Newbury, '01; L. L. Smith, '90; B. B. Ramey, '10; J. K. Stotz, '16.
Edgewood. R. S. McWhinney, '14.
Edgewood Park. L. V. Lewis, '05.
Edgeworth. W. D. Shields, '07; F. South, '12.
Erie. C. P. Anderson, '13; D. Arbuckle, '15; E. W. Bacon, M. Bradt, '13; C. E. Carter, '06; F. B. Downing, '95; E. A. Hahl, '09; A. G. Kessler, '08; R. C. McElroy, '12; F. B. McBrier, '96; D. C. Miller, '12; C. H. Schum, '95; M. E. Smith, '06; E. E. Walker, '03; L. T. Whiteheat, '96.
Farrell. S. Short, '08.
Ford City. W. R. Valentine, '94; R. L. Clause, '14.
Forty-Fort. W. H. Mainwaring, '05; E. H. Weston, '11; W. H. Yeager, '06.
Franklin. H. M. Hughes, '13; A. S. Meldrum, '11; M. W. Sherwood, '99; E. D. Smith, '78.
Germantown. J. H. Baker, '07; A. M. Harrington, '05; P. E. Hurd, '13; J. D. Kennedy, '98; R. T. Mickle, '92; A. S. Tourison, '02.
Gettysburg. S. R. Wing, '10.
Greensburg. K. H. Bais, '11; E. B. Kenly, Jr., '13.
Greenville. W. O. Tillotson, '96.
Halifax. C. S. Ryan, '14.
Hamburg. W. E. Wanner, '13.
Hanover. R. B. Beahm, '13; C. V. Brough, '05; G. H. Zouck, '11.
Harrisburg. C. N. Behrens, '12; H. R. Behrens, '12; F. M. Masters, '08; W. Calder, '17; H. T. Male, '09; L. D. Perry, '07; A. S. Schultz, '09; H. S. Shope, '08; E. W. Whited, '12.
Hazelton. N. R. Butler, '11; W. C. M. Butler, '11; J. J. Cuyle, '00; S. S. Oberender, '06; A. S. Littleton, '94.
Highspire. M. J. Hocker, '08.
Holidaysburg. J. D. Hartman, '03; P. S. Duncan, '98.
Irwin. J. W. Miles, '93.
Ingraham. W. R. Wrigley, '15.
Jersey Shore. A. A. Raymond, '10.
Johnstown. F. W. Krebs, '12; J. E. Kress, '91; R. Leventry, '10; R. W. Jones, '15; P. M. Price, '07; R. R. McClenahan, '05; G. H. Rabd, '09; H. L. Replogle, '07; R. H. Wolle, '13.
Kingston. D. P. Carter, '04; E. H. Millard, '16; H. A. Nugent, '07; A. H. Partridge, '99; H. M. Poust, '13.
Kimmelton. G. J. Kirbs, '95.
Lancaster. W. A. Heitshu, '03; J. E. Hess, '00.
Lansdowne. P. M. Russell, '15; A. Wilson, '10.
Lanes Mills. F. A. Humphreys, '04.
Lansford. A. E. James, '10.
McKeesport. T. S. Arnold, '08; E. Heusen, '96; R. J. Lane, O. M. Mowat, '89.
Media. T. Sauliner, '16; C. S. Wolrall, '05.
Mercersburg. H. V. Black, '01.
Milton. E. I. Hecht, '11.
Middletown. J. Young, '05.
Monessen. G. M. Ballou, '07.
Monongahela. F. P. Keller, '91.
Morris Run. C. G. Morgan, '98.
Mount Airy. H. A. Rogers, '03.
Mount Joy. E. E. Brown, '12.
New Castle. H. D. McCreary, '10; W. F. Moody, '02.
Northeast. J. E. Elwood, '07.
Northumberland. E. W. K. Cornwell, '15.
Newton Square. J. V. Colpitts, '09.
Norristown. J. C. Moyer, '00.
Oakmont. E. H. Best, '14; R. D. Thomas, '06.
Oak Lane. J. G. D. Fry, '09; C. H. Congdon, '16.
Oil City. C. W. Roess, '93.
Palmerton. C. E. Grimes, '10.
Patton. S. T. Brown, '17.
Pottsville. H. D. Baggerley, '06.
Philadelphia. H. L. Ames, '07; F. C. Andrews, '97; C. C. Antony, '95; J. P. Badenhauser, '00; H. P. Baker, '08; G. W. Barton, '94; H. Beyer, '02; R. E. Bishop, '09; T. D. Bowes, '05; L. Bremer, '08; G. W. Borton, '95; H. C. Bossinger, '10; R. E. Brown, '16; A. T. Bruegel, '96; C. R. Buck, '97; H. W. Butterworth, Jr., '11; H. B. Brazier, '92; R. M. Campbell, '02; E. B. Carter, '99; G. H. Chase, '02; H. N. Comins, '10; P. B. Chambers, '11; H. T. Coates, '00; C. H. Congdon, '16; T. F. Crawford, '05; I. L. Craig, '08; J. M. Denny, '92; W. L. DeLaney, '07; C. M. DeVed, '06; W. F. Dorner, '01; G. G. Durham, '05; C. F. Dye, '14; H. C. Earle, G. A. Eagan, '06; S. K. Eastwood, '13; S. B. Eckert, '08; H. T. Edsall, '96; C. D. Ehret, '97; F. W. Eveland, '05; W. S. Fogg, '12; I. C. Forshee, '05; J. W. Gray, '91; F. Gilkeson, '13; W. W. Goetz, '11; S. D. Gridley, '08; J. Harvey, '16; E. M. Hawley, '05; H. B. Hackett, '06; J. E. Harris, '04; L. H. Heist, '05; R. A. Hentz, '11; H. J. Hotchkiss, '96; R. W. Howe, '08; J. P. Hichok, '11; E. A. Hill, '15; A. Hiltebrant, '15; T. M. Jackson, '08; H. H. Ingersoll, '15; J. L. Janeway, '07; C. H. Johnson, '07; R. P. Johnson, '12; R. E. Joslyn, '05; R. R. Keely, '00; C. T. Keet, '15; W. O. Kellogg, '96; M. H. Leidy, '12; F. Leighton, '05; J. P. Leinroth, '12; R. B. Lewis, '95; C. E. Lex, '09; J. C. Lynch, '96; P. S. Lyon, '12; B. Margerum, '06; A. D. McCurdy, '07; B. F. Mechlvig, '05; R. C. Meyer, '11; R. A. Millar, '00; A. H. Millar, '05; W. H. Miller, '13; W. T. Mohan, '98; J. Monroe, '09; L. G. Morse, '06; A. C. Mott, '00; J. J. Montgomery, '03; T. V. Olsen, '03; G. F. Ott, Jr., '07; J. N. Pew, '08; McR. Parker, '15; A. S. Penney, '02; H. C. Pierce, '06; D. R. Richie, '97; J. W. Randall, '98; A. L. Register, '89; E. A. Rumsey, '90; G. A. Rumsey, '93; W. V. Sauter, '10; J. C. Shaw, '04; A. J. Sichtermann, '09; H. K. Schoff, '08; H. K. Seeley, '10; N. Shapiro, '12; F. Short, '13; W. W. Sibson, '93; W. W. Slaymaker, '12; I. B. Smith, '92; D. V. Stahl, '14; W. B. Stanford, '99; H. C. Strauss, '97; K. S. Stuart, '97; E. A. Steele, '06; H. C. Sutton, '08; G. W. Tall, '13; C. K. Taylor, '06; J. H. Taussig, '97; E. Trainer, '13; H. H. Thayer, '00; E. F. Tucker, '12; W. B. Wait, '08; F. A. Wallace, '08; C. M. C. Watt, '04; A. E. Welch, '13; C. H. Wetzel, '13; J. T. Worthley, '06; F. R. Whiting, '13; J. L. Wentz, '08; T. S. Westervelt, '96; F. B. Wetherill, '10; H. M. Wharton, '91; H. B. Wille, '92; E. R. Wood, '97; D. S. Woods, '04; H. B. Vincent, '04; C. Burpee, '17; R. C. Coursen, '17; H. M. Molony, '17; E. W. Siebert, '17.
Pittsburgh. C. S. Abbott, '12; A. C. Amsler, '09; O. L. Amsler, '00; W. O. Amsler, '95; E. C. Batchelar, '04; F. W. Berry, '94; H. S. Beatty, '03; J. R. Balsley, '14; J. E. Barney, '99; H. F. Bellis, '11; W. O. Beyer, '02; G. H. Best, '13; A. Blood, '13; F. A. Bonebrake, '13; E. H. Brown, '91; H. G. Burd, '09; J. A. Carothers, '14; F. T. Cooper, '11; R. M. Cornell, '09; D. K. Coyle, '09; J. F. Craig, '12; J. D. Crawford, '08; H. M. Curry, '09; E. P. Dandridge, '05; W. A. Dick, '92; J. W. Dix, '94; B. C. Dennison, '08; R. J. Donovan, '00; J. C. Drumm, '11; G. V. Dutney, '10; A. H. Eberts, '08; J. H. Edwards, '14; C. T. Edgerton, '01; R. N. Ehrhart, '01; W. S. Elliott, '87; W. K. Frank, '11; J. E. Fawell, '09; T. E. Graff, '96; L. V. Grantier, '01; K. W. Gass, '12; A. W. Grant, '09; L. J. Gray, '96; F. G. Grimshaw, '00; F. W. Heisley, '14; C. M. Herbert, '97; A. Heidt, '11; C. R. Hodges, '14; F. B. Hufnagel, '09; J. A. Hunter, '00; J. H. Hunter, '03; S. V. Hoffman, Jr., '13; E. N. Joseph, '01; L. H. Kehle, '00; W. C. Kennedy, '07; A. H. Kenneweg, '04; J. E. Kessler, '12; A. E. Kirk, '99; A. Kingsbury, '89; H. Knox, '02; C. F. Kress, '92; G. T. Ladd, '95; C. H. Loughridge, '04; H. R. Loughridge, '09; L. K. Lynn, '06; H. B. Mann, '06; J. W. Macfarlane, '07; J. W. Marshall, '08; W. W. Matchneer, '10; W. A. May, '94; T. B. McIntire, '10; W. R. McKown, '07; H. P. Menges, '10; H. J. Miller, '07; W. C. Morgenstern, '10; J. A. Morton, '09; E. H. Newbury, '01; J. C. Morrow, '08; H. M. Palmer, '92; F. H. Parke, '92; R. A. Parke, '80; L. M. Perkins, '15; W. H. Phillips, '12; S. C. Preston, '06; W. M. Robbins, '09; W. A. Rowe, '03; W. S. Ralston, '94; W. B. Reich, '15; L. Richardson, '10; S. N. Riter, '97; J. R. Robinson, '91; J. H. Schellentrager, '10; C. G. Schleuderberg, '02; H. M. Selling, '13; G. H. Stanion, '99; G. R. Stewart, '06; W. R. Scott, '14; H. E. Smith, '05; J. L. Smith, '04; W. D. Taylor, '13; F. H. Thatcher, '96; G. B. Thorpe, '16; L. L. Thurston, '12; C. F. Tiers, '00; W. J. Todd, Jr., '16; G. E. Turner, '93; J. H. Twin, '12; A. F. Tydeman, '10; W. L. Umstadt, '89; W. S. Unger, '16; J. H. Vohr, '16; R. C. Warner, '07; W. H. Watson, '12; A. G. Williams, '03; W. S. Wing, '07; H. H. Wood, '92; T. C. Wurts, '13; A. W. Wycoff, '96; F. H. Zimmers, '12; F. P. Zoch, '08; A. M. Hagen, '17; S. O. Law, '17.
Pittson. F. W. Cool, '00.
Plymouth. J. B. Smith, Jr., '03; P. A. Williams, '17.
Pottsville. J. M. Swalm, '12; R. A. Swalm, '14; J. Wood, '06.
Punxsutawney. H. H. Van Kennan, '15.
Reading. A. S. Blanchard, '00; L. T. Heizmann, '05; L. Illmer, '01; D. G. McCann, '12; C. M. Rick, '06; H. T. Shick, '90; L. T. Shartel, '17; E. L. West, '00; G. B. Woodhull, '00.
Ridgway. D. L. Barbour, '16; C. M. Cross, '04; R. C. Ecclestorn, '00; T. Hall, '94; H. A. Otterson, '97; P. R. Swift, '07; M. E. Thompson, '90.
Ridgewood. W. A. Nickerson, '13.
Rochester. E. W. Bentley, '94.
Rosemont. J. J. Derham, '17.
Sayre. D. A. Loveland, '07; T. D. Weaver, '97.
Scranton. W. L. Acker, '05; G. L. Bascome, '05; C. H. Beach, '03; A. B. Clemens, '92; E. G. Coursen, Jr., '10; W. H. Davidsen, '14; C. P. Davidson, '13; R. Davis, '11; F. N. Hallstead, '09; L. W. Healy, '90; H. W. Hull, '92; J. B. Kelly, '05; H. S. Krauter, '07; H. T. Kuschke, '03; W. H. Lewis, '06; R. B. McClave, '11; W. F. Monley, '04; J. F. Mears, '06; J. E. Parrish, F. T. Platt, '92; R. H. Rissinger, '14; C. H. Severance, '11; J. M. Shackford, '76; G. M. Taylor, '05; J. T. Thomas, '05.
Sewickley. W. B. Miller, '99; W. G. Moore, '06; A. Starr, '06; C. B. Starr, '14.
State College. G. D. Robinson, '14.
Sharon. N. G. Brayer, '05; W. B. Caldwell, '12; W. L. Gable, '10; J. V. Rose, Jr., '13; R. T. Hanford, '97; I. P. Kittredge, '02; C. A. Lytle, '96; G. S. Warren, '05; H. M. Wilson, '91; S. M. Phillips, '11.
Sharpsville. J. J. Pierce, '95.
Shamokin. J. A. Britton, '96.
Shenandoah. J. G. Retick, '11.
Slatington. C. A. Haines, '08.
Somerset. G. J. Krebs, '92.
South Bethlehem. L. Levine, '12; L. H. Lipps, '13; H. J. Seaman, '12; L. Tschirky, '12; S. Vivo, '11; E. C. Wilson, '11.
St. Davids. J. C. Smaltz, '15.
Steelton. J. W. Magoun, '12.
Swarthmore. G. W. Lewis, '08.
Swissvale. J. L. Reno, '09; G. H. Armstrong, '11; M. S. Higgins, '06; A. L. Vencill, '07.
Summerville. C. S. Baldwin, '10.
Sunsbury. H. W. Guyer, '96.
Tacony. C. F. Merz, '12; H. B. Merz, '14.
Tamaqua. S. Kitchell, '06.
Tarentum. R. Pitcairn, '03.
Titusville. C. C. Hogg, '14; C. L. Warner, '95.
Towanda. R. B. Pratt, '14; R. Hale, '07.
Troy. W. H. Parsons, '04.
Tunkhannock. S. D. Streeter, '96.
Turtle Creek. A. P. Woods, '10.
Truchlers. W. M. Kuntz, '97.
Tyrone. Y. H. Mills, '13.
Ulster. E. T. Horton, '11.
Ulysses. I. C. Lewis, '99.
Uniontown. G. Porter, Jr., '97; O. L. Collier, '03.
Warren. W. W. Beaty, '96; H. P. Hue, '96.
Washington. H. O. Anderson, '07; B. E. Northup, '10; E. S. Greer, '10.
Wayne. J. G. Shaeffer.
Waynesboro. D. D. Huyett, '12; H. L. Landis, '08; M. H. Landis, '08; C. F. Meyer, '10.
Weatherly. R. A. Blakslee, '00.
Wellsboro. N. Houston, '13.
West Auburn. A. Jayne, '10.
Westchester. A. C. Rakestraw, '99.
Westgrove. L. B. Jones, '04.
Wilkes-Barre. K. Atkinson, '12; D. Bunting, '94; R. B. Carr, '12; J. M. Coughlin, J. H. Doughty, '99; F. B. Howell, '15; R. O. Jones, '90; J. L. Stearn, '13; E. B. Wagner, '06; C. B. D. Wood, '09; S. V. Wood, '10.
Wilkinsburg. W. J. Auburn, '97; C. C. Brinton, '08; D. C. Dawkins, '15; A. P. Deemer, '05; G. P. Jackson, '08; P. H. Knight, '92; J. J. Miles, '09; F. M. Mizushi, '15; B. F. Key, '09; H. C. Mode, '97; I. Motokawa, '16; H. C. Nagel, '04; W. F. Patton, '06; L. I. Rees, '15; H. D. Murdock, '90; F. Rowe, '10; B. P. Rowe, '92; G. J. Schmidt, '07; H. L. Slauson, '10; A. Snyder, '07; J. W. Todd, '06; H. A. Travers, '06; J. S. Holliday, '06.
Williamsport. R. K. Cheney, '03; E. M. Link, '08; C. W. Salladd, '96; F. Van Fleet, '76.
Wilderding. J. S. Beswick, '14; L. E. Lyttle, '96.
Wilpen. J. M. Mull, '09.

Wyncote. C. P. Hubbard, '15.
Winton. G. L. Schuerr, '10.
York. E. T. Brandt, '10; G. E. Evans, '11; F. Downs, '14; H. B. Hull, '13; W. C. Suiter, '13; G. C. Ruby, '15.
York Haven. W. L. Mann, '03.

RHODE ISLAND

Fort Adams. A. Norton, '11.
Kingston. J. S. Beamensderer, '11.
Newport. G. H. Bevins, '96; B. S. Cottrell, '97; J. H. Lopez, '17; O. R. Rice, '97; H. G. Simmons, '01.
Providence. R. E. Ostby, '06; C. A. Rich, '94; G. L. Spencer, '97; A. G. Vail, '09; W. Beckwith, '09; R. H. Dunbar, '13; R. I. Worrell, '11.
Pawtucket. O. S. Suyder, '10.
Woonsocket. L. W. Ballou, '96; R. C. Newcomb, '06.

SOUTH CAROLINA

Blackville. H. W. Mathews, '96.
Charleston. O. L. Coward, '08; J. H. Klinck, '94; G. W. McIver, '96; L. Tiedeman, '07.
Clemsen College. S. B. Earle, '02.
Darlington. H. S. Haynsworth, '13.
Greenville. A. Barnes, '99; A. Rose, '92.
Greenwood. A. F. McKissick, '95.
Piedmont. S. M. Beattie, '11.
Pelzer. R. B. Stewart, '17.
Pomaria. W. C. Summer, '06.
Rock Hill. W. H. Wylie, '11.
Spartanburg. R. H. Chapman, '17; F. L. Bryant, '99.
St. Mathews. D. K. Banks, '17; M. H. Banks, '11.
Sumter. A. C. DeLarme, '15.

SOUTH DAKOTA

Huron. F. D. Brown, '03.
Lead. G. Hendryx, '15.
Oacoma. J. A. Wheeler, '06.
Rapid City. S. R. Halley, '14.
Yankton. H. E. Hastings, '01.

TENNESSEE

Chattanooga. W. Barnum, '93; A. O. Berry, '01; W. L. Catlin, '00; D. P. Montague, '76; F. A. Stivers, '13.
Clarksville. H. N. Morrow, '09.
Copperhill. R. Knapp, '15.
Johnson City. A. Smith, Jr., '02.
Knoxville. F. R. Jones, '88; J. A. Switzer, '96.
LaFollette. A. D. McFarlane, '02.
McMinnville. A. D. Alcott, '07.
Memphis. W. C. Alexander, '05; W. D. Carr, '12; H. A. Darnell, '15; R. J. Hockney, '08; J. Phelan, '09; J. B. Rozier, Jr., '09.
Nashville. F. Hune, '05; H. P. Connell, '11.

TEXAS

Amarillo. A. F. Steubling, '11.
Austin. F. E. Cardullo, '01.
Beaumont. W. C. Averill, '11; M. A. Hartnett, '07; R. J. Lighthall, '05.
College Station. H. E. Smith, '87; J. E. Lear, '05; S. E. Herrington, '10.
Commerce. C. J. Rutland, '15.
Corsican. W. T. Damon.
Dallas. H. R. Aldredge, '13; C. C. Allex, '10; C. Burgher, O. Carter, '13; E. S. Fletcher, '05; C. L. Loos, '01; F. D. Nevins, '12; F. R. Slater, '94; F. I. Clark, '98; H. R. Cooper, '04; H. See, '09.
Denison. J. S. Morris, '17.
Eagle Pass. T. R. Jones, '17.
El Paso. J. N. Childs, '10; M. E. Jones, '98; E. W. Saner, '14; N. R. Stansel, '03.
Fort Worth. L. E. Barrows, '07; C. L. Hoera, '14.
Freeport. B. Andrews, '95.
Galveston. C. L. Gillespie, '03; W. D. Masterton, '06; H. J. Runge, '10.
Hondo. J. D. Shaw, '04.
Houston. H. E. Chambers, '11; C. A. Cleaver, '04; J. K. Dorrance, '10; P. W. Fenton, '15; H. W. Fletcher, '15; H. L. Koenig, '03; L. D. Hall, '09; G. H. Jones, '08; A. J. Stude, '11; F. W. Masters, '05; H. F. Smith, '11; J. P. Van Vorst, '08.
Marshall. J. B. Schrott, Jr., '04.
McKinney. H. F. McDonald, '01.
Kerrsville. A. C. Schreiner, '01.
Mercedes. W. F. Shaw, '94.
Paris. R. Rosentengel, '12; D. F. Tinnin, '08.
Port Arthur. W. C. Kammerer, '17.
Sherman. J. F. Hendricks, '15.
San Antonio. F. G. Chamberlain, '12; C. W. Herpel, '04; R. Jones, '10; L. A. Oppenheimer, '14.
Texarkana. I. J. Kosminsky, '07.
Waco. A. D. Brinkerhoff, '05.

UTAH

Bingham Canyon. R. Timmerman, '06.
Dragon. G. W. Morse, '94.
Farmington. O. R. Clark, '12.
Garfield. T. Becker, '93.
Green River. H. L. Chapman, '04.
Ogden. A. R. Oliver, '11.
Provo. A. R. Cota, '16; F. C. Noon, '11; S. D. Oliver, '15.
Richfield. H. B. Waters, '03; F. J. Wight, '12.
Salt Lake City. P. P. Ashworth, '14; C. G. Bamberger, '08; E. H. Beckstrand, '01; F. C. Brundage, '06; R. J. Cooper, '08; W. L. Emery, '97; C. J. Evans, '12; G. T. Ingersoll, '83; E. L. McCurtain, '17; W. H. McIntyre, '11; O. W. Ott, '03; R. A. Petit, '07; H. L. Rasmason, '10; P. S. Rattle, '05; L. J. Riter, '08; O. J. Salisbury, '05; R. W. Salisbury, '06; L. W. Sowles, '06; J. C. Squires, '15; D. S. Wegg, '12; J. B. Walker, '12; H. D. Wells, '02; S. Williams, '10; T. J. Yates, '02.

VERMONT

Bellows Falls. S. C. Hale, '12.
Milton. B. C. Brown., '13.
Readsboro. H. B. Nye, '12.
Rutland. E. L. Olney, '96; A. A. Swinnerton, '09.
Swanton. H. M. Bell, '00.
Townsend. O. B. Danchy, '93.
Wilder. C. E. Carpenter, '12.

VIRGINIA

Alexander. J. C. Ramage, '90.
Alexandria. A. Weil, '13.
Clifton Forge. B. F. Donovan, '97.
City Point. C. G. Lee, Jr., '07; W. W. Woodruff, '11.
Cismont. O. E. Herring, '02.
Clarendon. C. C. Hough, '17.
Danville. L. N. Dibble, '07.
Evington. F. Saunders, '99.
Fort Monroe. E. K. Smith, '06; R. E. Vose, '03.
Featherstone. F. R. Chambers, Jr., '97.
Fort Myer. H. W. Huntley, '04.
Front Royal. L. Swan, '11.
Luray. E. E. Grove, '09.
Midway Falls. T. R. Torian, '03.
Millwood. G. P. Harrison, '01.
Newport News. C. Ashby, '01; A. A. Booth, '15; G. C. Decker, '09; R. A. Gross, '14; P. F. Halsey, '15; S. I. Hess, '14; C. G. Jewell, '06; J. H. P. Kiescker, '96; J. A. Maclay, '15; W. W. Manville, '06; W. T. Newell, '15; H. F. Norton, '96; H. P. Phelps, '09; T. W. Ross, '95; D. C. Shepard, '17; H. A. Wadman, '13; J. B. Weaver, '02.
Norfolk. J. W. Brownley, '14; L. F. Bruce, '03; A. W. Chase, '08; R. H. Gurley, '09; W. J. Harris, Jr., '05; W. R. James, '17; F. Lewis, '06; G. H. Lewis, '97; D. F. Mann, '07; R. J. Neely, '01; A. Stamford, '99; E. R. Southerland, '09; T. P. Thompson, '98.
Petersburg. B. M. Hill, '07; D. Spotswood, '97.
Plymouth. R. M. Cox, '10.
Radford. J. Ingles, '97.
Richmond. R. C. Ancarrow, '14; H. E. Baskerville, '89; D. L. Boyd, '04; J. J. Ewing, '90; T. C. Gordon, '06; A. L. Johnson, Jr., '04; J. M. Johnston, '06; T. B. Powers, '15; R. E. Wall, '10; G. H. Whitfield, '96; C. E. Wings, Jr., '03; F. T. Wood, '06.
Roanoke. E. C. McComb, '88; J. A. Pilcher, '92; J. M. Thomas, Jr., '94.
Saltville. W. D. Mount, '90; F. D. Lindquist, '15.
Staunton. E. S. Baker, '07; H. B. Liggett, '12; W. S. Moffett, '02.
Suffolk. A. E. Lockwood, '12; C. T. Taylor, '95.
Warrentown. D. M. Warren, '06.

WASHINGTON

Bellingham. H. W. Grant, '12.
Bremerton. C. A. Whipple, '03.
Clarkston. W. E. Mohundro, '15.
Clear Lake. C. M. Cole, '06.
East Seattle. R. Leiser, '00.
Everett. F. W. McChesney, '10.
Huntsville. L. A. Corbett, '11.
North Yakima. J. S. Shedden, '04.
Port Townsend. C. J. Goodier, '07; D. E. Lain, '85.
Seattle. J. H. Adams, '98; H. J. Armstrong, '93; R. C. Barton, '06; W. T. Burwell, Jr., '08; A. C. Denny, '15; A. S. Downey, '99; E. A. Duffy, '04; A. W. Fisher, '14; W. B. Hanford, '13; D. W. Hartzell, '08; R. Howes, '98; J. D. Hull, '03; F. N. Kollock, '97; J. Kuhn, '92; C. B. Lamont, '00; H. Lee, '97; M. R. McMicken, '14; C. C. May, '10; J. M. Moran, '06; J. D. Mudge, '04; F. C. Perkins, '01; J. L. Reese, '14; O. C. Spencer, '06; H. G. Stern, '06; W. M. Tompkins, '15; D. S. Updegraff, '07.
Spokane. A. H. Candee, '06; W. E. Chase, '00; W. V. Kelley, '93; C. R. McBroom, '15; H. G. Miller, '96; W. N. Paine.
Tacoma. E. H. Baker, '11; S. E. Blunt, '09; E. D. Judson, '14; L. G. Knapp, '04; W. L. Hoffman, '98; V. Morrill, '14.
Wenatchee. A. E. Wieland, '00.

WEST VIRGINIA

Charleston. R. H. Cunningham, '11; P. J. Goodwin, '08; H. S. Johnson, '96.
Clarksburg. J. A. Clark, '10; E. Hart, '16; L. L. Tonkin, '12.
Eccles. W. H. Keller, '94.
Elm Grove. A. L. Milton, '15.
Fairmont. G. W. DeBolt, '14; B. F. Grimm, '14; R. L. Kingsland, '05; W. S. Mayers, '92.
Huntington. H. J. Berry, '10.
Keyser. W. B. Woolf, '05.
Morgantown. W. E. Dickinson, '04; F. L. Emory, '96; J. B. Grumheim, '14; C. R. Jones, '00.
Martinsburg. O. L. Bender, '08; G. Hetzel, '00.
Moundsville. K. A. Page, '08.
Wheeling. H. C. Hazlett, '02; C. E. Lang, '99; H. M. Sawyer, '11; A. C. Stiffel, '03; D. H. Wagner, '98; N. P. Whitaker, '96.
Winterburn. T. R. Craig, '15.

WISCONSIN

Appleton. T. E. Orbison, '10.
Beloit. A. E. Ashcraft, '03; H. Brewer, '94; C. A. Lee, '06.
Berlin. E. L. Walker, '02.
Clintonville. E. A. Taylor, '14.
Cudahay. S. W. Hartley, '01.
Daisy. S. L. Thayer, '92.
Eau Claire. H. J. Thompson, '14.
Green Bay. A. S. Cargill, '12.
Jefferson. W. G. Mack, '93.
Kenosha. J. S. Whyte, '13.
LaCrosse. L. C. Hirshheimer, '03; C. H. Holway, '06.
Mayville. R. P. Sauerherring, '00.
Madison. N. D. Betts, '03; A. G. Christie, '05; J. R. DuPriest, '13; C. W. Lange, '05; J. D. G. Mack, '88; D. Montgomery, '06; W. Montgomery, '03; A. R. Nottingham, '11.
Manitowoc. J. F. Pritchard, '13; W. L. Wallace, '06; C. C. West, '00.
Marinette. J. A. Cook, '92.
Milwaukee. E. T. Adams, '94; R. W. Allen, '12; T. E. Beddow, '09; A. W. Berresford, '93; L. B. Birckhead, '12; P. H. Birckhead, '16; G. S. Blankhorn, '08; J. H. Boughton, '03; F. S. Bosworth, '12; F. J. Brewer, '12; G. W. Collins, '95; G. F. DeWein, '97; R. M. Dixon, '13; G. F. Fenno, '06; J. R. Ferguson, '03; R. E. Friend, '08; P. W. Gross, '14; C. B. Holden, '01; A. C. Holtz, '15; R. L. Hustis, '07; H. S. Kingsley, '14; R. V. Krause, '08; R. E. Laley, '13; H. D. Lindsay, '10; W. F. Lynaugh, '11; R. B. Mann, '95; R. A. McKee, '97; C. F. Perry, '04; W. F. Peterson, '11; W. H. Powell, '01; F. M. Prescott, '85; E. C. Read, '17; W. R. Read, '15; H. P. Reed, '09; L. G. Shepard, '03; J. L. Snyder, '13; F. L. Sivger, '03; W. F. Steel, '04; L. L. Tatum, '97; W. H. Tompkins, '91; L. R. Vantrot, '12; G. H. Walder, '09; M. Washburn, '14; F. C. Wehr, '12; E. C. Welborn, '03; R. C. Werner, Jr., '08; R. B. Williamson, '93; H. N. Wade, '14; J. C. Wilson, '06; E. P. Wilson, '11.
Mount Vernon. W. W. Stebbins, '97.
Neenah. E. D. Beals, '03.
Oshkosh. J. G. B. Lambert, '13.
Ostburg. E. B. Gage, '95.
Palmyra. O. H. Bigelow, '07.
Platteville. C. Kimball, '94.
Racine. H. A. Uihlein, '08; R. P. Gilbert, '11; H. B. Underwood, '07.
Sheboygan. J. C. Vollrath, '17.
Superior. M. C. Bright, '17; B. S. Loney, '14.
Waukesha. W. D. Johnston, '17; C. R. Stull, '07.
West Allis. R. L. Alexander, '00; T. M. Heermans, '10; C. L. Page, '97.
Whitewater. G. L. Teeple, '89.

WYOMING

Cheyenne. D. S. Dickert, '11.
Dayton. R. H. Depew, Jr., '13.

UNITED STATES DEPENDENCIES

Ancon, Canal Zone. W. A. Godbold, '11.
Canal Zone. C. J. Embree, '05.
Conefields, Alaska. L. R. Ebert, '05.
Ewa, Hawaiin Islands. J. L. Renton, '12.
Fort De Russy, Hawaii. R. L. Tilton, '11.
Fort Grant, Panama. J. B. Mitchell, '95.
Gatun, Canal Zone. E. J. Atkisson, '11.
Guayama, Porto Rico. D. Bruno, '06.
Hilo, Hawaii. A. A. Scott, '08.
Honolulu, Hawaii. R. A. Anderson, '16; A. H. Case, '16; S. N. Castle, '06; C. S. Hollway, '94; J. M. Young, '02.
Juneau, Alaska. S. E. Hodge, '03.
Lahaima, Hawaii. C. A. McDonaul, '96.
Lazardo, Porto Rico. J. Zalduonda, '95.
Manila, P. I. F. A. Barton, '91; J. F. Branagan, '14; R. Earnshaw, '17; I. C. Hartigan, '08; J. C. Rockwell, '07; M. J. Salos Y. Rodriguez, '12; A. C. Sullivan, '09; L. L. Vincent, '11; C. L. Williams, '05; P. H. Williamson, '10; J. Xeres-Burgos, '09; F. Ycasiano-Roxas, '07.
Mayaguez, Porto Rico. J. L. Cabassa, '12.
Naguabo, P. R. B. B. DeWitt, '10.
Oahu, Hawaii. F. Phisterer, '95.
Panama, Canal Zone. T. R. Murphy, '10.
Ponce, Porto Rico. J. C. Besosa, '94; L. E. Gowling, '11; L. A. DeParrata-Doria, '14; E. P. Valdiveeso, '97; J. Clavell, '12; J. Seix, '98.
Rampart, Alaska. C. H. Crippen, '15.
Santurce, Porto Rico. E. E. Merino, '15; J. Annex, Jr., '16.
San Juan, Porto Rico. H. Abarca, '09; L. Benitez, Jr., '12; C. R. Hartzell, '13; J. Marxnach, '06; R. M. Palmer, '12.
Skagway, Alaska. V. I. Hahn, '90.

FOREIGN COUNTRIES

Aguacate, Cuba. J. Gomez, '00.
Allahabad, India. H. T. Avery, '12.
Aregrupa, Peru. C. Martinez, '09.
Asuncion, Paraguay. J. Alonzo, '12; L. I. Guanes, '12; S. D. Silva, '12.
Athens, Greece. S. S. Chryssides, '06.
Aylmer, Canada. J. J. Church, '79.
Banes, Cuba. J. J. Ruiz, '17.
Bienne, Switzerland. P. E. Brandt, '04.
Bisley, Surrey, England. F. W. Poat, '05.
Bordeaux, France. R. H. Andrews, '11.
Bournville, Birmingham, England. H. Papazia, '15.
Bowmanville, Ont., Canada. H. E. Paetow, Jr., '12.
Brampton, Can. R. S. Haggert, '86.
Brisbane, Australia. L. C. Robertson,'15; P. L. Day,'11; W. A.Weedon,'07.
Brockville, Ontario, Canada. C. T. Wilkinson, '96.
Buenos Aires, Argentine. I. S. Alcacer, '14; J. H. Dunn, '05; W. A. Reece, '06; D. Espindola, '11; A. O. de Retana, '14; R. Roth, '09.
Caracas, Venz. C. S. Diaz, '97.
Calcutta, Ind. W. K. Ashmead, '15.
Canton, China. K. L. Yen, '18.
Cardenas, Cuba. S. C. Sardina, '14.
Charlottenburg, Germany. W. H. Mathies, '02.
Chiengmai, Siam. H. P. Reid, '11.
Chihuahua, Mexico. H. O. Underhill, '14; J. R. Wilson, '95.
Chiguitoy, Tuyillo, Peru. A. F. Larco Y. Herrera, '98.
Christiania, Norway. C. W. Steen, '08.
Clariente, Cuba. F. R. Ginonis, '07.
Chugking, China. M. K. Tsen, '14.
Coahuila, Mexico. C. A. Martinez, '05.
Cobourg, Ontario, Canada. B. C. Bell, '13; C. W. Dohenny, '13.
Copper City, B. C., Can. P. R. Backus, '99.
Chiriqui, Panama. de Obaldia, '13.
Christchurch, New Zealand. E. T. Reece, '03.
Durango, Mexico. J. Guerrero, '96; M. Guerrero, '95.
Dusseldorf, Germany. A. G. Piedbouef, '03.
Eglinton, Canada. H. S. Sarven, '96.
Enith, England. C. E. Rogers, '96.
Falmouth, Cornwall, England. F. B. Dwight, '09.
Femmins, Ont. Can. P. A. Robbins, '94.
Foochow, China. F. S. Chun, '14.
Fort George, Canada. H. B. Close, '05.
Galt, Ont., Can. J. F. MacGregor, '92.
Gananogue, Ont., Can. F. B. Cowan, '91.
Granada, Nicarauga. S. A. Guillen, '01; S. E. Munoz, '92.
Grand Mere, P. Q., Can. W. Marshall, '11.
Grand Forks, British Columbia. G. D. Clark, '95.
Greytown, Sas., Can. D. S. Simpson, '07.
Guayama, P. R. F. F. Vidal, '16.
Guanajuato, Mex. H. P. Smith, '99.
Guatemala, S. A. S. C. McNider, '93.
Guayaquile, Ecuador, S. A. F. A. Bolona, '11; R. S. Luna, '00.
Hague, Holland. E. W. Thompson, '81; J. S. Van Bijevelt, '07.
Hamilton, Ont., Can. H. M. Bostwick; W. W. Cushing, '05; G. R. Harvey, '93; W. F. McLaren, '94; J. F. Merrick, '17; T. A. Rice, '16; C. W. Robinson, '94; E. Strasburger, '96; P. C. Wiggin, '11.
Hamilton Parish, Bermuda. F. Outerbridge, '77.
Hankow, China. S. C. T. Sze, '05.
Hangchow, China. C. Yang, '16.
Harbin, Manchuria. H. R. Wilde, '05.
Havana, Cuba. A. B. Aquilero, '16; M. J. Andux, '13; J. Batista, '14; M. V. Cuervo, '06; B. Johnson, '78; A. Maceo, '06; C. A. Peasant, '13; J. R. Perez, '14; R. W. Tassie, '09; H. A. Taviera, '03; T. C. Ullbright, '08; A. S. Williams, '04.
Hoikow, China. K. L. Yen, '15.
Hong Kong, China. M. T. Jones, '13.
Ilhas Minas, Brazil. F. E. A. Leite, '94.
Iqueque, Chile, S. A. C. J. Billwiller, Jr., '06.
Johannesburg, S. Africa. J. Adenforf, '07; J. F. Cook, '93; J. W. Kirkland, '87.
Kalgan, China. C. F. How, '13.
Kanayawa, Japan. K. Hayashi, '04.
Karachi, India. L. L. Porter, '12.
Kentville, Nova Scotia, Canada. F. J. A. McKittrick, '98.
Kimberley, S. A. A. F. Williams, '97.
Kiang, China. C. B. Brown, '04.
Kingston, Ont., Can. G. H. Gordon, '95.
Kobe, Japan. S. Osame, '01.
Kozimachi-Ku, Tokio, Japan. Y. Tokatsuji., '98.
Lachine, Quebec, Can. L. S. Eaton, '11; F. G. Mallock, '11.
LaPaz, Bolivia, S. A. J. H. Merrill, '02.
La Plata, Argentine Rep. A. Ortizde Rozas, '04.
Le Havre, France. W. H. Reid, '11.
Lima, Peru. M. A. Calderon, '05; Larrabure, '09; G. Tindels, '06; A. Valladeres, '06; M. C. Velarde Y. Cobian, '04.
London, England. J. H. Massie, '01; A. E. Reinke, '96.
Manati, P. R. G. S. Van Wickle, '02.
Manchester, England. J. S. Peck, '92; C. E. Renold, '06.
Marash, Asia Minor. N. H. Suren, '79.
Managua, Nicaragua, C. A. R. Flint, '87.
Matanzas, Cuba. C. Dumas, Jr., '06; P. Uriuza Y. Bea, '89.
Melbourne, Australia. J. M. Grant, '11; H. W. Smith, '08.
Mendoza, Argentine Rep. J. J. Corti, '11.
Mexico City, Mex. A. G. Baldwin, '99; M. Barcho, '15; H. P. Lewis, '99
Mogi, Japan. T. Minomiya.
Montevideo, Uruguay. A. C. Towers, '11.
Montreal, Canada. W. J. Armstrong, '08; A. Dulcos, '10; J. H. Glen, '98; R. G. Harris, '97; A. R. Henry, '93; T. Hersey, '88; N. W. Howard, '07; W. W. Kingsley, '01; B. T. McCormick, '03; M. W. Plumb, '09; J. C. Smith, '00; W. H. Wardwell, '97; J. H. Wynne, '98.
Morrisburg, Ont. Can. J. H. Meikle, '94.
Nankow, China. P. Wang, '09.
Nagasaki-ken, Japan. C. Toyomura, '13.
Natanzas, Cuba. J. M. Valdes, '16.
New Chang, Man., China. E. T. Hobart, '08.
New Brunswick. W. R. Turnbull, '93.
Niagara Falls, Ont., Canada. C. A. Lauderdale, '02; W. J. Russell, '13; R. E. Strawbridge, '13.
Oaxaco, Mexico. R. Leon, '04.
Ottawa, Ont., Canada. N. F. Ballantyne, '93.
Odessa, Russia. P. K. Browd, '91.
Osaka, Japan. J. Hoshino, '05.
Pachuca, Hidalgo, Mex. J. E. Smith, '11.
Panama, S. A. P. G. Arosemena, '09; O. A. Ycaza, '94.
Paris, France. M. S. Levy, '09; N. C. Mason, '09; J. A. Setna, '13.
Parka Balranold, N. S. W. Australia. L. M. McPherson, '07.
Parana, E. Bois, Arg. Rep. F. J. Broguet, '09.
Pekin, China. L. Y. Chang, '12; Y. T. Chen, '14; E. F. Wei, '12.
Petrograd, Russia. A. M. Hamilton, '09; W. A. Rumf, '79; S. B. Wright, '12.
Petrovsky, Kharior, Russia. P. W. Sookatschoff, '01.
Pueblo, Mex. M. Rangel, '13.
Quebec, Can. H. H. Latimer, '09.
Rio De Janiero. J. H. T. Aquino, '77; A. R. Coimbra, '85; E. Lix-Klett, '08; A. C. Brazil, '07; R. J. Shalders, '04; H. M. Sloat, '04.
Rugby, England. H. N. Sporborg, '99.
Sao Paulo, Brazil. C. Barros, '04; V. Barros, Jr., '15; L. C. Berrini, '09; D. R. Goncalves, '14; B. Jordao, '78; J. L. Keese, '13; P. de Lima, '15; V. D. Sampaio, '07; R. M. Sampaio, '08; J. P. Tibynca, '79.
Santa Fe, Argentine Rep. J. U. Aguirre, '10.
St. Catherines, Ont. Can. P. H. Hamilton, R. B. Hamilton, '98; E. Heitman, '95; F. W. Throop, '92.
Saint Denis, Seine, France. W. H. Squire, '97.
Salta, Argentine Rep. B. Colind, '14; C. Lopez, '15; E. Outes, '13.
San Juan, Argentine Rep. A. Sarmiento, '08; H. N. Wood, '93.
Santiago, Chile. M. E. Bonyum, '97.
Schaneberg, Berlin, Germany. G. A. Illmer, '09.
Shanghai, China. T. Y. Chen, '09; J. Chow, '15; P. F. Chu, '09; H. P. Sailor, '06; D. C. Reib, '15; K. L. C. Sun, '10; W. S. Tong, '13; S. Z. Yang, '15.
Seoul, Korea. S. D. Heun, '04.
Sharvinigan Falls, Canada. L. C. Eddy, '10.
Sidney, Australia. S. H. Baraclough, '94; J. C. Close, '05; H. R. Halloran, '06; G. K. Johnston, '00; W. H. Mason, '07; A. Maughan, '06.
Scottegen, Belgium. J. Van Lierde, '09.
Smyrna, Asia Minor. C. P. Ballodus, '95.
Tampico, Mexico. J. A. Ostos, '08.
Tangshan, China. M. Shen, '14.
Tanphan, China. P. B. Benton, '11.
Teddington, England. G. Savory, '04.
Tientsin, China. K. T. Tsai, '09; K. L. Wu, '05.
Tocapilla, Chile. N. Rowe, '93; C. G. Spencer, '04.
Tokio, Japan. R. Ban, '14; I. Ito, '08; P. Messer, '94; T. Nakagawa, '09; S. Sano, '00; Y. Sekiguchi, '03; S. Tsuchiya, '13; S. Yamazaki, '02.
Toronto, Can. H. E. Bullis, '10; F. G. Clark, '94; W. F. Dean, '89; F. F. Espenschied, '05; L. R. Evans, '07; J. H. Hall, '96; W. J. Herdman, '06; W. W. Lovell, '97; A. P. McClintock, '10; D. C. Mix, '05; F. R. Oates, '10; L. B. Reed, '95; J. C. Reed, '92; A. F. Reese, Jr., '14.
Trujillo, Peru, S. A. J. L. Armas, '14.
Tucuman, Argentine Rep. O. L. R. Rapelli, '10.
Valparaiso, Chile. G. S. Lang, '03.
Vancouver, B. C., Can. T. W. Baker, '08; C. N. Beebe, '05; E. J. Booth, '08; C. F. Boyce, '00; M. D. Rector, '09.
Vera Cruz, Mex. F. M. Saqui, '10.
Victoria, Arg. Rep., S. A. J. Reggiardo, '12.
Victoria, B. C., Can. W. J. Sutton, '78.
Welland, Ont., Can. A. J. Hathaway, Jr., '10; H. C. Herpel, '06; C. E. Murray, '03; R. C. Thompson, '09.
Westmount, Quebec, Can. T. J. Ashe, '04.
Winnipeg, Man., Can. C. H. Baird, '05; G. B. McColl, '06; C. B. Piper.
Yarmouth. W. J. Hibbert, '97.
Yokahoma, Japan. W. H. Taylor, '13.

DECEASED SIBLEYITES

ABRAHAMS, Morriz Landa, M.E., '06. Died May 28, 1911 at San Antonio, Tex.
ADAMS, Francis Salisbury, M.E., '08. Died August 9, 1913 at Rochester, Minn.
ADAMS, William Napoleon, '76. Died August 12, 1910 at Taylorville, Ill.
AHRENS, Richard Conrad, '10. Died at Crockett, February 15, 1907. Pneumonia.
ALLAN, Edwin Phipps, '02. Died November, 1913, Montclair, N. J.
ALLAN, Francis Ramsey, M.E., '04. Died Dec. 15, 1906, Brooklyn, N. Y.
ALLEN, John Granger, '81. Died 1884.
ALMY, Arthur Leroy, M.E.E., '95. Died Jan. 19, 1900 at Auburn, N. Y.
ALTAMIRANO, Garcia Manuel, '10. Died Mar. 10, 1908 at Ithaca, N. Y.
ALTEMOSE, Earl Stanley, M.E., '07. Died Oct. 21, 1914 at Buffalo, N. Y.
ANDERSON, Rufus, B.M.E., '73. Died at Southampton, Mass.
ARNOLD, Bishop, '80. Died Feb. 16, 1897 at Rochester, N. Y.
ARNOLD, Charles Joseph, M.E., '92. Died Oct. 12, 1908 at Geneva, N. Y.
ATWATER, Henry Harrison, jr., '01. Died July 31, 1906.
AYER, John Varnum, '95. Died ———.
BABCOCK, Edward Clarence, '78. Died January 1, 1910 at Hershey Ave. Hotel, Los Angeles, Cal.
BAILEY, Frank Eugene, '94. Died suddenly while installing a plant in Allentown, Sept. 10,1910.
BAKER, Julius Fred, M.E.E., '00. Died Jan. 31, 1912.
BALLARD, John Carlos, M.E., '07. Died. Feb. 9, 1908 at Plainfield, N. J.
BARRETT, Henry Endson, '89. Died Feb. 5, 1904 at Owego, N. Y.
BARRETT, Saxton Swaynee, M.E. (E.E.), '98. Died Aug. 7, 1912 at Chicago, Ill.
BASSETT, Deane Hendrick, '07. Died Dec. 8, 1907 at ———, Pa.
BATEMAN, James Garfield, M.E., '07. Died Oct. 29, 1910 at New Westminster, B. C., Canada.
BATT, Ireaus Augustus, M.E., '10. Died ——— at Ashville, N. C.
BELLOWS, Walter Everett, E.E., '96. Died Apr. 4, 1910 at Rutherford, N. J.
BELSEY, Clay (Benj. Franklin), M.E., '98. Died Sept. 3, 1910 at Peoria, Ill.
BENDER, Oswald Lewis, M.E., '08. Died Dec. 4, 1915 at Princeton, N. J.
BENNETT, Edwin Howard, jr., '89. Died Feb. 21, 1912 at Berlin, Germany.
BENNET, Orville Green, M.E., '04. Died February 28, 1917.
BENNETT, Harry Phineas, '01. Died Nov. 2, 1913 at Butte, Montana.
BERGER, John Jacob, M.E., '87. Died Oct. 24, 1889 at Troy, N. Y.
BISHOP, Roberts Huntington, '07. Died Oct. 13, 1909 at Elmira, N. Y.
BLACKBURN, Harold Coleman, M.E., '16. Died October 26, 1916 at Hartford, N. J.
BLAKE, Charles Glenville, M.E., '10. Died March 31, 1914 at Pittsburgh, Pa.
BOBB, Ralph Daniel, '09. Died Nov. 28, 1907 at San Antonio, Texas.
BOGARDUS, William Bailey, M.E., '02. Died Nov. 1, 1905 at Spokane, Wash.
BOGLE, Walter Scott, jr., M.E., '01. Died Jan. 11, 1907 at Chicago, Ill.
BONSALL, William Lewis, '96. Died March 11, 1894 at Los Angeles, Cal.
BOUGHTON, Judson Hartwell, M.E., '03. Died July 29, 1916 at Milwaukee, Wis.
BOWEN, Ernest Spence, M.E., '90. Died April 27, 1912 at Geneva, N. Y.
BOYD, Edward Armstrong, '98. Died June 12, 1900 at New York, N. Y.
BOYD, Robert, jr., '91. Died July 26, 1898 at ———.
BRAYTON, Clarence Edward, '96. Died September 20, 1898 at Camp Mead.
BRIETWIESER, Herman George, E.E., '02. (Hopelessly insane. Request has been made that no further publications be sent him.)
BROOKS, William Benthall, jr., '92. Died Feb. 8, 1903 at New York, N. Y.
BROWN, Alba Fisk, '77. Died ——— at Pittsburgh, Pa.
BROWN, Goodwin (Nathaniel), '75. Died July 18, 1912 at Rochester, N. Y.
BRUESSL, Elbert Albert, E.E., '93. Died Aug. 22, 1903 at ———.
BURR, Harry Kent E., '94. Died May 8, 1902 at ———.
BURRETT, William John, '99. Died March 4, 1906 at Brooklyn, N. Y.
BURNHAM, Ernest Franklin, '13. Died Feb. 18, 1911 at Homer, N. Y.
BUTTON, Charles Edward, '06. Died Feb. 12, 1907 at Phoenix, Arizona.
CADY, Daniel Stanton, '80. Died Nov. 4, 1914 at Utica, N. Y.
CALDWELL, Edward Chapin, '03. Died April 4, 1900 at Milton, Pa.
CARLTON, William Dean, M.E., '11. Died June 3, 1913 at East Orange, N. J.
CARPENTER, Charles Francis, B.M.E., '76. Died Jan. 29, 1888 at Albany, N. Y.
CARPENTER, Harris Irving, '78. Died Oct. 26, 1904 at Milford, Mass.
CARR, Leonard Jarvis, M.E., '01. Died June 16, 1902 at Ogdensburg, N. Y.
CASTRO, Thomaz D'Acuimoe, '77. Died April 22, 1897 at ———.
CHARTERS, Samuel Barclay, M.E., '04. Died Dec. 29, 1912 at Pittsburgh, Pa.
CHRISTOPHER, Frank Howell, '96. Died April 4, 1893 at ———.
CHURCHILL, William Wilberforce, M.M.E., '90. Died March 4, 1910 at Oshkosh, Wisc.
CLISDELL, Percy Alfred, E., '90. Died Jan. 10, 1912 at New York, N. Y.
COFFIN, John, '81. Died Sept. 3, 1889 at Johnstown, Pa.
COHEN, Alan Mordecai, '93. Died Sept., 1913 at Baltimore, Md.
COLEMAN, Edgar Park, M.M.E., '95. Died Nov. 27, 1910 at Buffalo, N. Y.
COLWELL, John Alexander, jr., '92. Died Aug. 6, 1913 at Anniston, Ala.
COMESKY, John, '93. Died February 14, 1916 at Norwalk, O.
CONNARD, Frank Leavenworth, M.E., '93. Died Jan. 21, 1908 at Philadelphia, Pa.
CORMAN, Bruce Hall, M.E., '06. Died June 1, 1906 at Ithaca, N. Y.
CORNELL, Ezra, E., '87. Died May 13, 1902 at Ithaca, N. Y.
CRANE, William Foster Day, E.E., '87. Died April 28, 1903 at Orange, N. J.
CROUCH, Harold Chester, M.E., '00. Died Oct. 29, 1903 at Boulder, Colo.
CRUICKSHANKS, John DeWitt, '93. Died 1898 at ———.
CRUIKSHANKS, Lyle, M.E., '92. Died Oct. 10, 1902 at Carthage, N. Y.
CUERVO, Y NOREIGA Jose Maria, M.E., '98. Died Aug. 8, 1907 at New York, N. Y.
CULVER, William Horace, '78. Died April 16, 1891 at Bay City, Mich.
CUMMINS, Howell Adin, '81. Died Dec. 10, 1899 at ———.
CURTIS, William Elliott, '03. Died Jan. 14, 1905 at Norwalk, Conn.
DANIELS, Herbert Lane, E.E., '97. Died March 8, 1912 at Paradox, Colo.
DARLINGTON, William, M.E., '86. Died Aug. 15, 1897 at B. C., Canada.
DAVENPORT, Isaac, M.E., '04. Died at New Orleans, La.
DAVENPORT, John K. W., E., '00. Died Aug. 27, 1908 at Ben Avon, Pa.
DAVIS, Thomas Robert, '07. Died Nov. 3, 1911 at Forest City, Ark.
DEAMER, John Ellsworth, '87. Died July 6, 1901 at Cleveland, O.
DEAN, John Kingsbury, '91. Died ———.
DECATUR, Jay Halsey, '07. Died June 24, 1905 at Amsterdam, N. Y.
DEMAREST, John V. B., '97. Died March 20, 1901 at Paterson, N. J.
DENNETT, William Alexander, M.E., '07. Died Aug. 12, 1911 at Kittery, Me.
DERCUM, Max, M.E., '97, M.M.E., '98. Died June 3, 1898 at Ithaca, N. Y.
DEVIN, Abe, '87. Died June 30, 1885 at Livermore Falls, N. Y.
DE VOY, James F., Special '92. Died Nov. 5, 1915 at Milwaukee, Wisc.
DICKSON, Charles C. B., M.E., '08. Died Aug. 2, 1913 at New Orleans, La.
DIMON, Theodore, M.E., '98. Died July 9, 1908 at Utica, N. Y.
DULANEY, Stanley Joe, M.E., '08. Died Feb. 15, 1914 at Phoenix, Ariz.
DUNBAR, Charles H., E., '92. Died April 21, 1915 at Waverly, N. Y.
DUNCAN, John D., E. M.M.E., '94. Died July 13, 1910.
DUNHAM, Linderman H., '14. Drowned July 15, 1913 in Silver Lake, Perry, N. Y.
EBERHARDT, Elmer Gould, M.E., '04. November 21, 1908 at Newark, N. J.
EDDY, John George, jr., '17. Died Feb. 15, 1915 at Fort Meyers, Fla.
EDSON, Herman A., '02. Died Oct. 28, 1911 at New York City.
ENDRESS, William Fitzhugh, M.E., '10. Died Sept. 7, 1915 at sea, aboard S. S. Alliance.
FAIRBANKS, Leland, '82. Died Dec. 13, 1882 at McKeesport, Pa.
FARWELL, Frank Mason, '91. Died Aug. 2, 1913 at Kansas City, Mo.
FERGUSON, Henry Alex, '90. Died April 29, 1911 at St. Louis, Mo.
FIELD, Edward Loyd, '79. Died March 22, 1914 at New York City.
FIERO, Harry Hunt, '01. Died Aug. 24, 1898 at Ithaca, N. Y.
FISCHER, Schuyler Lyon, M.E., '99. Died Nov. 28, 1902 at Canon City, Colo.
FISK, Marion Walter, M.E., '07. Died Jan. 21, 1910 at Portland, Ore.
FLOY, Henry, M.E., '91. Died May 5, 1916 at New York City.
FOLK, Frederick J., E., '01. Died Feb. 24, 1903 at Brooklyn, N. Y.
FOLLMER, William W., M.E., '01. Died Feb. 17, 1902 at Pittsburgh, Pa.
FOWLER, Henry Douglas, '11. Died Sept. 29, 1907 at Ithaca, N. Y.
FOX, Harry D., M.E., '08. Killed May 23, 1915 in automobile accident near Hall, N. Y.
FRAGUER, Albert, '90. Died May 8, 1908 at Brooklyn, N. Y.
FRANK, Leo Max, M.E., '06. Died July 16, 1915 at Marietta, Ga.
FRIEDRICH, John Emil, M.E., '07. Died July 26, 1911 at Utica, N. Y.
FROST, Francis R., E., '93. Died Dec. 29, 1913 at Los Vegas, New Mexico.
FURTER, Warner Hudzagh, '17. Died Oct. 28, 1915 at Ithaca, N. Y.
GAGE, John, '03. Died Jan. 18, 1904.
GALLIHER, Ernest J., '97. Died Dec. 3, 1893 at Ithaca, N. Y.
GATES, Everett Laverne, '11. Died Oct. 4, 1911 at New York City.
GEER, Herbert G., M.E., '93. Died March 7, 1900 at Baltimore, Md.
GILLIS, William Davis, M.E., '87. Died June 24, 1891 at Kinsman, O.
GILMOUR, Matthew, jr., '03. Died Aug. 28, 1904.
GODDARD, Joseph Sterling, M.E., '94. Died November 23, 1916 at Riverside, Ill.
GORKE, William Robert, '00. Died October 13, 1901.
GOSMAN, Harry N., Special '13. Died March 27, 1910 at Ithaca, N. Y.
GOUGH, John Bernard, '96. Died April 28, 1905.
GRAHAM, LeRoy Worden, M.E., '97. Died Dec. 12, 1898.
GRAHAM, William Townsend, jr., '99. Died 1899.
deGRAIN, Edward R. S., M.E., '03. Died Oct. 26, 1904 at Garrett, Ind.
GRANT, Cleveland P., '91. Died Dec. 7, 1893 at Cortland, N. Y.
GRANT, Floyd, M., E., '95. Died Dec. 26, 1897 at Schoharie, N. Y.
GREGG, Arthur S., '79. Died 1881.
GREGORY, Floyd Delos, '16. Died March 17, 1914 at Mt. Vision, N. Y.
GRELLE, Frederick W., '10. Died Dec. 7, 1906 at Ithaca.
GRETH, John C. W., E., '97. Died Aug. 8, 1915 at Gibsonia, Pa.
GULDI, Walter Edward, '18. Killed in accident December 25, 1916 at Sayville, N. Y.
GUNDELFINGER, Walter D., M.E., '04. Died Sept. 5, 1908 at Scranton, Pa.
deHAAN, Jacob E., '96. Died Sept. 22, 1896 at Toronto, Can.
HACK, Earl Reside, M.E., '08. Died March 13, 1910 at Brunswick, Md.
HAMILTON, Millard Caldwell, M.E., '88. Died June 23, 1893 at Omaha, Neb.
HARRIS, Benjamin Marvin, M.E., '90. Died May 2, 1896 at Agua, Calientes, Mexico.
HARRIS, Paul Cherington, '93. Died Feb. 10, 1905 at San Francisco, Cal.
HARRISON, Raymond High, M.E., '10. Died July 10, 1916 at Orange, N. J.
HART, Haynes Lloyd, M.E., '07. Died Jan. 4, 1912 at New Rochelle, N. Y.
HARTZELL, Cyrus King, '07. Died Dec. 14, 1907 at Denver, Colo.
HASKELL, Alvin, '18. Died Oct. 4, 1914 at Ithaca, N. Y.
HAWES, Arthur St. Clair, '04. Died June 10, 1998 at Denver, Colo.
HEGELER, Herman, '94. Died Aug. 29, 1913 at Chicago, Ill.
HEILMAN, Charles Jones, E.E., '97. Died Sept. 22, 1911 at Elizabeth, N. J.
HEILMAN, Oren Gibson, M.E., '91. Died July 17, 1894 at Williamsport, Pa.
HEMMING, Carl Bryant, M.E., '09. Died Dec. 30, 1912 at Milwaukee, Wisc.
HERNANDEZ, Rafael, '93. Died ———.
HILL, John Thomas, B.M.E., '78. Died Feb. 10, 1910 at Niagara Falls, N. Y.
HILLS, John Stuart, M.E., '99. Died July 26, 1909 at Santa Cruz, Cal.
HINSDALE, William Moses, '02. Died Dec. 5, 1910 at Fulton, N. Y.
HITCHCOCK, Edward Northup, '93. Died Sept. 29, 1901 at Hilo, H. I.
HIXSON, Joseph Foster, '78. Died July 31, 1913 in California.
HOGDSON, Joseph Ernest, E.E., '97. Died Oct. 26, 1913 at Gloversville, N. Y.
HOERNER, John Hanna, '09. Died Jan. 17, 1914 at New Orleans, La.
HOLMES, Howard Bernard, '95. Died Dec. 20, 1906 at Chicago, Ill.
HOPKINS, Jesse James, M.E., '88. Died Sept. 11, 1888 at Springfield, Ill.
HOTCHKISS, Frank Whitman, '05. Died Aug. 23, 1902 at Lewiston, N. Y.
HOWELL, Louis Baldwin, E., '95. Died Nov. 11, 1896 at Chicago, Ill.
HOYT, Carroll Livingston, M.E., '92. Died Jan. 29, 1895 at Rochester, N. Y.
HUBBARD, Lewis Kellsey, '02. Died Feb. 25, 1903 at Middletown, Conn.
HUDSON, Neal Morehouse, '06. Died March 19, 1905 at Weedsport, N. Y.

HULETT, JOHN, M.E., '97. Died Jan. 31, 1903 at Monongahela, Pa.
INGALLS, ROYCE KNOWLTON, '95. Died April 27, 1894 at ———.
INSLEE, JAY CROSS, '98. Died Jan. 2, 1897 at Newark, N. J.
ITTNER, CONRAD SMITHMAN, '74. Died March 26, 1916 at St. Louis, Mo.
JOHNSON, FREDERICK MAURITZ, '04. Died June 3, 1904 at Worcester, Mass.
JONES, EDWARD COLE, M.E., '95. Died Oct. 13, 1910 at Fort Atkinson, Wisc.
JOST, FREDERIC WILLIAM, '93. Died March 18, 1908 at Devon, Pa.
KENNEDY, DWIGHT BRUCE, '90. Died Feb. 25, 1909 at Oakmont, Pa.
KENT, ARTHUR ZENAS, B.M.E., '76. Died Feb. 24, 1888 at Ithaca, N. Y.
KERR, JOHN LAWYER, M.E., '89. Died July 31, 1907 at Franklin, N. Y.
KERR, WALTER CRAIG, B.M.E., '79. Died May 8, 1910 at Rochester, Minn.
KETCHAM, CORNELIUS STARLYN NEWELL, E., '03. Died July 31, 1904 at Pittsburgh, Pa.
KIEHLE, JAMES SCOTT, '10. Died Jan. 31, 1908 at Ithaca, N. Y.
KILGOUR, CASSIUS MATHERS, '96. Died Aug. 26, 1903 at ———.
KINSEY, ARTHUR, '98. Died July 16, 1897 at Claverack, N. Y.
KIPP, WHITNEY, '11. Died at New York City.
KIRKUP, HAROLD BENJAMIN, M.E., '12. Died March 23, 1916 at Bellevue Hospital, New York City.
KITTREDGE, ROBERT JOSIAH, E., '96. Died Oct. 28, 1907 at Lyons S. Falls, N. Y.
KNAPP, ROBERT SHAKELTON, '05. Died March 12, 1903 at Waverly, N. Y.
KOHLS, OTTO WILLIAM, '96. Died Feb. 16, 1903 at Ithaca, N. Y.
KOHRS, WILLIAM, '01. Died March 21, 1901 at New York City.
KRAMER, CHARLES ALBERT, '90. Died Feb. 26, 1906 at Niagara Falls, N. Y.
KUEHNS, ROMEO BENVENUTO, M.E.,'07. Died April 23, 1911 at New York City.
LANGE, JOHN, M.E., '93. Died April 2, 1894 at Poughkeepsie, N. Y.
LANPHEAR, BURTON SMITH, E., '94, M.M.E., '95. Died Oct. 14, 1904 at Carthage, N. Y.
LANSING, GEORGE HERBERT, '95. Died Aug. 26, 1909 at ———.
LATTA, GUY WILLIS, '95. Died Feb. 23, 1899 at Mexico City, Mex.
LEAVITT, PARKMAN, '12. Died Jan. 24, 1908 at Ithaca, N. Y.
LEGGETT, MORTIMER MARCELLUS, '77. Died Oct. 10, 1873 at Ithaca, N. Y.
LEWIS, MCCREERY, '03. Died Nov. 20, 1907 at Gunnison, Colo.
LEWISHON, SAMUEL ADOLPHUS, '96. Died 1898 at ———.
LINEN, GEORGE GRIFFITH, '88. Died Aug. 17, 1908 at Auburn, N. Y.
LINKE, J. RALPH AUDLEY, '94. Died March 15, 1902 at Cripple Creek, Colo.
LIFE, CHARLES EHLE, B.M.E., '73. Died March 17, 1895 at Syracuse, N. Y.
LIFE, CLIFFORD EHLE, M.E., '11. Died Feb. 7, 1916 at 112 Summit Ave., Syracuse, N.Y.
LIPPERT, FREDERICK CHARLES, M.E., '05. Died June 8, 1911 at Lynchburg, Va.
LITTLE, PAUL HOPKINS, E.E., '97. Died April 15, 1898 at Middletown, N. Y.
LOEBER, HERMAN FELIX, '99. Died Jan. 22, 1910 at Vancouver, B. C.
LOMBARD, EDWARD CRAFFS, '91. Died Feb. 20, 1904 at Jackson, Mich.
LONG, ALBERT BUCHANAN, LL.B., '13. Died Jan. 23, 1916 at Lewiston, Pa.
LOOMIS, CLARENCE EDWARD, E.E., '88. Died Sept. 6, 1891 at Denver, Colo.
LOVELAND, FRANK DEWOLF, M.E., '02. Died Oct. 14, 1911 at ———.
LYON, CHARLES ADELBERT, '05. Died March 27, 1907 at East Orange, N. J.
LYON, PHILIP SCHUYLER, M.E., '89. Died June 1, 1890 at Chicago, Ill.
MCCARN, VOLNEY NELSON, E., '98. Died Dec. 25, 1902 at Andover, N. Y.
MCCOLLUM, JOSEPH GRANT, M.E., '09. Died Jan. 13, 1915 at Newark, N. J.
MCGILLIVRAY, CLIFFORD BOTTSFORD, '99. Died June 11, 1915 at ———.
MCGLENSEY, JOHN FRANKLIN, E., '96. Died Nov. 11, 1911 at St. Louis, Mo.
MCGOWIN, RICHARD SMYTH, E., '98. Died Feb. 12, 1912 at Cynwyd, Pa.
MACKINLAY, EDWARD SCOFIELD, JR., M.E., '06. Died Dec. 15, 1911 at Denver, Colo.
MCNEIL, THOMAS, E., '95. Died March 14, 1906 at Pittsburgh, Pa.
MAC NIDER, JAMES WRIGHT, '95. Died May 26, 1906 at New York City.
MAKINO, KINGS, '08. Died Feb. 1, 1915 at Tokyo, Japan.
MALLERY, FORD EMETTE, '91. Died July 3, 1890 at ———.
MANDELL, FRANK HART, '91. Died May 1, 1893 at Chicago, Ill.
MANNING, SAMUEL, E.E., '94. Died Nov. 25, 1913 at Syracuse, N. Y.
MARCA ROMERO, MANUEL ANTONIO, M.E., '07. Died April 10, 1914 at City of Belem, State of Para, Brazil.
MARVIN, ROSS GILMORE, A.B., '05. Died April 10, 1909 at Cape Columbia, Arctic Ocean.
MASON, JOHN PARK, '79. Died July 4, 1910 at Elmira, N. Y.
MATTHEWS, CHARLES PHILO, E.E., '92, Ph.D., '01. Died Nov. 22, 1907 at Phoenix, Ariz.
MEANS, ARCHIBALD LAYNG, '95. Died Aug. 20, 1899 at Colorado Springs, Colo.
MERGENTHALER, FRITZ LILLIAN, '04. Died Aug. 9, 1910 at Cape May, N. J.
MEYER, EDGAR JOSEPH, M.E., '05. Drowned April 15, 1912, Atlantic Ocean, Steamer Titanic.
MEYER, PERCY BAILDON, '01. Died Oct. 8, 1901 at New York City.
MILLER, CHARLES PHILIP, M.E., '90. Died March 17, 1905 at Newark, N. J.
MILLINGTON, GEORGE JOSEPH, E.E., '01. Died June 15, 1905 at Buffalo, N. Y.
MINER, MAX HOWARD, M.E., '99. Died Nov. 7, 1905 at Brooklyn, N. Y.
MOORE, HARLAN FLAVIUS, M.E., '93. Died April 28, 1895 at Boston, Mass.
MORGAN, RICHARD EVANS, E.E., '96. Died Feb. 4, 1900 at New York City.
MORRIS, JOHN THERON, '73. Died May 25, 1914 at Varna, N. Y.
MORSE, EVERETT FLEET, B.M.E., '84. Died Nov. 11, 1913 at Ithaca, N. Y.
MOSELEY, EDWARD ALLEN, '95. Died ———.
MUEDEN, RUDOLF EDWARD, M.E., '03. Died May 25, 1907 at Washington, D. C.
MULLIKIN, CLARK WASGATT, '94. Died Dec. 22, 1891 at Cincinnati, O.
MURPHY, EMERY DAVID, '10. Died Sept. 28, 1910 at Pittsburgh, Pa.
NAKAI, TOMIKICHI, '08. Died Sept. 7, 1905 at New York City.
NASH, ELBERT TODD, '17. Died Feb. 7, 1914 at Ithaca, N. Y.
NEWBERY, GEORGE ALEJANDER, '95. Killed by fall of aeroplane March 1, 1914 at Mondoza, Arg. Rep., S. A.
NEWTON, JAMES DYNAN, E.E., '95. Died Aug. 9, 1912 at Chicago, Ill.
NICHOLS, CHARLES HENRY, '93. Died April 21, 1912 at Logansport, Ind.
NICHOLS, WILLIAM HOLMES, '07. Died Dec. 7, 1906 at Ithaca, N. Y.
NOE, FREDERICK, M.E., '97. Died Oct. 3, 1903 at Newburgh, N. Y.
NUTTING, RAYMOND, '04. Died Feb. 20, 1911 at Aparoma, Peru, S. A.
OHLMEYER, HENRY CHARLES, '94. Died Dec. 26, 1902.
ORCHARD, PAUL BARTLETT, '10. Died Feb. 1, 1911 at San Francisco, Cal.
ORTON, ALBERT LOSSING, E.E., '95. Died May 4, 1908 at Banning, Cal.
OSTRANDER, FRANK MERCER, '76. Died May 20, 1890 at Mercer, Cal.
PADGAM, FRANK WILLIAM, M.E., '88. Died Jan. 26, 1891 at Syracuse, N.Y.
PALMITER, CLEBRON WOOD, '14. Died November 6, 1916 at Watertown, N. Y.
PARDESSUS, FLORIAN GEORGE, '04. Died Aug. 21, 1904 at Lake Memphremagog, Can.
PARIS, WILLIAM ALBERT, '91. Died May 12, 1907 at Edgewood Park, Pa.
PARK, WILLIAM OSBORN, '93. Died May 6, 1902 at Atchinson, Kansas.
PARKER, HOMER JAY, E.E., '97. Died Nov. 27, 1910 at Ann Arbor, Mich.
PASSMORE, JOHN FAXON, M.E., '13. Died March 9, 1917 at Wilmington, Del.
PETERS, GUS TRIMBLE, '95. Died Jan. 4, 1904.
PETRIE, THOMAS KYDD, '10. Died July 23, 1910 at Philadelphia, Pa.
PHILLIPS, FRANKLIN, '78. Died Feb. 9, 1914 at Newark, N. J.
PICKERING, CLARENCE HADLEY, E.E., '96. Died Aug. 13, 1899 at Pontiac, Mich.
PIFFARD, HENRY HAIGHT, '93. Died Sept. 29, 1892 at New York City.
PLUMB, HYDE PARKER, E.E., '95. Died Dec. 15, 1902 at Delta, Colo.
POTTER, WILLIAM RECHNER, '72. Died July 6, 1888 at Kingwood, W. Va.
PRESTON, CHARLES SEYMOUR, '94. Died Dec. 17, 1898 at Wheeling, W. Va.
PRINCE, JOHN, M.E., '14. Died Aug. 1914 at New York City.
PURMAN, WILLIAM MILLER, E.E., '95. Died May 16, 1906 at Schenectady, N. Y.
RAMEL, GEORGE REGIS, M.E., '05. Died June 24, 1907 at sea.
RAMSEY, HARRY NATHAN, E.E., '93. Died Nov. Nov. 4, 1906 at Augusta, Ga.
RAND, JASPER RAYMOND, JR., '97. Died March 30, 1909 at Salt Lake City, Utah.
RANDOLPH, CLYDE, M.E., '01. Died May 16, 1904 at Morgantown, W. Va.
REID, HERMON CAMP, M.E., '08. Died Dec. 28, 1908 at Brookton, N. Y.
REID, PAUL WILLIAM, M.E., '10. Died Oct., 1911 at Porto Velho, Brazil, S. A.
REILY, FREDERICK ASBURY, M.E., '10. Died March 6, 1916 at Waterbury, Conn.
REINHART, WILLIAM JEFFERIES, '03. Died Feb. 22, 1903 at Paterson, N. J.
RHODES, STEWART, '95. Died Oct. 30, 1903 at Honolulu, H. I.
RICHARDS, GEORGE E., '72. Died Sept. 15, 1874 at Farwell, Mich.
RICHTER, MARTIN LUTHER, JR., M.E., '06. Died Sept. 21, 1907 at Philadelphia, Pa.
RIDALL, JACOB COOK, '02. Died Sept. 19, 1901 at Pittsburgh, Pa.
RIDER, CHARLES ALDEN, '08. Died Dec. 19, 1905 at Holicong, Pa.
RITES, FRANCIS MARION, B.M.E., '81, M.E., '96. Died May 8, 1913 at Slaterville Springs, N. Y.
ROBERTS, WILLIS MARKEL, B.M.E., '83. Died Oct. 19, 1909 at Seneca Falls, N. Y.
RODRIGUEZ, JOSÉ ANTONIO, '91. Died ——— at Azusa.
ROSENTHAL, HERMAN SOLOMON, E.E., '01. Died May 17, 1903 at Chicago, Ill.
ROSS, CECIL METCALF, M.E., '02. Died Feb. 8, 1907 at Bolivia, S. A.
ROSS, ROBERT EMMETT, 2d, '11. Died Oct. 20, 1910 at Philadelphia, Pa.
ROWLANDS, EDWARD PRICE, E.E., '97. Died Aug. 6, 1912 at Aurora, N. Y.
RUGGLES, WILLIAM BARKER, B.M.E., '83. Died Jan. 23, 1916 at 91 W. 5th St., Bergen Point, N. J.
RYAN, JAMES HENRY, M.E., '09. Died Oct. 22, 1913 at Chicago, Ill.
SALISBURY, HERBERT LUCIUS, '81. Died Feb. 14, 1906 at Springfield, Mass.
SANDERS, RALSTON HARVEY, '96. Died Aug. 3, 1900 at Chicago, Ill.
SAWYER, NELSON WILLIAM, M.E., '04. Died Jan. 1, 1912 at Nogales, Ariz.
SAXTON, CHARLES BULLOCK, '94. Died July 20, 1900 at Greensboro, N. C.
SCARFE, CHARLES COOK, JR., '96. Died Dec. 31, 1915 at ———.
SCALES, HENRY JACKSPN, M.E., '06. Died April 20, 1915 at Atlanta, Ga.
SCHAEFER, EDWARD FRANKLIN, '02, M.M.E., '03. Died ———.
SCHAEFER, ERNEST CHARLES AUGUSTUS, '08. Died Jan. 23, 1908 at Ithaca, N. Y.
SCHMUCK, OLIVER LEROY, '07. Died Dec. 7, 1906 at Ithaca, N. Y.
SCHRAFT, FREDERICK LOUIS, E.E., '97. Died Aug. 25, 1909 at Buffalo, N. Y.
SCHRENDER, ANDREW MARTIN, M.E., '97. Died Jan. 1, 1913 at Germantown, Pa.
SCOTT, CLAUDE RUFUS, '89. Died ———.
SCOTT, FRANK JEREMIAH, B.M.E., '80. Died March 12, 1912 at Chicago, Ill.
SCOTT, QUINCY ADAMS, E.E., '94. Died June 16, 1913 at Pittsburgh, Pa.
SEAMAN, WILLIAM KELLEY, B.M.E., '78. Died July 2, 1883 at Throgg's Neck, N. Y.
SEEGAR, EDGAR PERCIVAL, E.E., '98. Died Nov. 3, 1901 at Ithaca, N. Y.
SEEP, WILLIAM JOSEPH, '96. Died at Titusville, Pa.
SEYMOUR, GEORGE MASTERS, JR., '07. Died May 10, 1905 at Ithaca, N. Y.
SHANTZ, OLIVER SCHEIRICH, E.E., '93, M.M.E., '99. Died Sept. 7, 1910 at Buffalo, N. Y.
SHEBLE, FRANKLIN, E.E., '88, M.S., '89. Died April 10, 1899 at Philadelphia, Pa.
SHELDON, FRANK WARREN, '86. Died Oct. 15, 1897 at Hoboken, N. J.
SHELDON, FRANKLIN LACY, M.E., '92. Died May 17, 1895 at New York City.
SHERMAN, NATHANIEL NORTON, '95. Died Oct. 22, 1893 at Watertown, N. Y.
SHIRAS, OLIVER, E.E., '97. Died Oct. 2, 1915 at St. Louis, Mo.
SHORT, FRANK JAMES, M.M.E., '07. Died Dec. 22, 1909 at Denver, Colo.
SIMMONS, HARRY LEE, '01. Died Nov. 15, 1912 at Washington, D. C.
SMEDLEY, GEORGE M., '96. Died July 28, 1904 at Oil City, Pa.
SMITH, AMOS BIRD, M.E., '07. Died Oct. 13, 1909 at Philadelphia, Pa.
SMITH, DAVID KEDZIE, '04. Died July 11, 1905 at Evanston, Ill.
SMITH, EMILIE, E.E., '94. Died Oct. 10, 1896 at Pittsburgh, Pa.
SMITH, HERBERT ROBERTS, '74. Died Sept. 21, 1898 at Boston, Mass.
SMITH, MURRAY HILTON, '93. Died Dec. 27, 1902 at West Baden, Ind.
SMITH, SHERMAN EDWIN, M.E., '00. Died Jan. 7, 1908 at Albuquerque, N. M.
SMITH, VICTOR EDWARD, M.E., '08. Died Feb. 11, 1910 at Bayonne, N. J.
SMITH, WILLIAM RALPH, '77. Died June 24, 1906 at Chicago, Ill.
SPENCER, HENRY KING, '90, M.M.E., '94. Died Aug. 9, 1911 at Neal Bay, Wash.
SPRINGER, ANTON, JR., '93. Died Jan., 1901 in the Philippines.
SPRINGER, PHILLIP GÜTTINGEN, '88. Died Jan, 18, 1912 at New York City.
SPURGIN, DAVID GILBERT, '92. Died July 29, 1900.
STEARNS, SUMNER EVERETT, E.E., '95. Died July 28, 1910 at Bison, Kan.
STEPHENS, DEWITT CLINTON, '95. Died April 20, 1915 at New York City.
STEPHENS, JAMES W., '01. Died in fall of 1911 at Phoenix, Ariz.
STEVENS, FREDERICK, '79. Died March 16, at Attica.
STEWART, HARRY KENNEDY, '08. Died Aug. 12, 1905 at Wichita, Kan.
STICHTER, JOSEPH TYBRAND, M.E., '11. Died Dec. 12, 1914 at Reading, Pa.
STILES, SYLVESTER PIERCE, '06. Died Oct. 31, 1903 in Colorado.
STRANAHAN, OLIN AMES, E.E., '90. Died Sept. 18, 1911 at New York City.
STRANE, JAMES ALBERT, '05. Drowned in Minnesota River, July 7, 1907 at ———, Minn.
STRATTON, FRANK LITTRELL, E., '01. Died July 9, 1914 at Louisville, Ky.

STUCKEY, Robert Lincoln, '05. Died March 30, 1903 at Buffalo, N. Y.
STURGES, Eben Perry, '03. Died Feb. 23, 1908 at Silver City, New Mex.
SWART, Richard Houghton, M.E., '95. Died June 7, 1895 at Auburn, N. Y.
TAYLOR, Edmund P., '95. Died Sept. 9, 1894.
TAYLOR, Frank E., B.M.E., '76. Died May 13, 1879 at Hinsdale, N. H.
TAYLOR, Gilbert, '07. Died March 16, 1909 at Liberty, N. Y.
THOMPSON, Charles Lea, '92. Died Jan. 9, 1902 at Pittsburgh, Pa.
TIDBALL, Alfred Dana, '97. Died Nov. 12, 1897 at Bronxville, N. Y.
TOBEY, William B., E., '90. Died March 28, 1896 at Guayaquil, Ecuador, S. A.
TOERRING, Christian J., jr., E., '93. Died April 22, 1910 at Philadelphia, Pa.
TREMAN, Ebenezer Mack, '72. Died Dec. 31, 1915 at Ithaca, N. Y.
TYLER, Caleb Ridgway, '07. Died Oct. 2, 1909, Schenectady, N. Y.
UNCKLES, Henry Weir, M.E., '10. Died Jan. 5, 1916 at Buffalo, N. Y.
UPHAM, Warren Kimey, '95. Died July 5, 1892.
VAN ALSTYNE, Thomas Jefferson, M.E., '03. Died Oct. 8, 1908 at Hanley, Canada.
VAN HOUTEN, Chauncey, '77. Died Nov. 16, 1900 at Ithaca, N. Y.
VAN SICE, Joseph, '72. Died Oct. 25, 1891 at Wampville, N. Y.
de VASCONCELLOS, Augusto Cezar, B.M.E., '78. Died Feb. 7, 1908 at Sao Paulo, Brazil.
VAUCLAIN, Samuel M., M.E., '02. Died March 26, 1913 at Rosemont, Pa.
VERNON, John, '06. Died Feb. 24, 1903 at Brooklyn, N. Y.
VICKERS, Albert E., '89. Died May 17, 1898 at Punta Arenas,Chile,S.A.
VINTON, James Chapin, '04. Died Feb. 14, 1903 at Ithaca, N. Y.
WALES, Ralph Avery, M.E., '02. Died July 7, 1908 at Elmira, N. Y.
WALKER, Fernando Murray, M.E., '05. Died 1910 at Cordoba, Argentine Republic.
WANZER, Charles Vernon, E., '97. Died May 27, 1897 at Ithaca, N. Y.
WARD, Herman Seelye, '96. Died Feb. 15, 1908 at San Bernardino, Cal.
WARE, Robert Galen, jr., M.E., '99. Died May 19, 1905 at Johnstown, Pa.
WARING, John, B.M.E., '84. Died June 9, 1901 at Hartford, Conn.
WATERBURY, Henry Talmadge, '81. Died May 8, 1910 at ———.
WATERMAN, John Sayles, B.M.E., '77. Died March 10, 1891 at Pittsford, Vt.
WEAVER, Norman R., '90. Died Sept. 30, 1897 at Selma, Ala.
WELLER, Ralph Charles, '06. Died 1904.
WELLS, Alfred Tennyson, '03. Died Aug. 22, 1900 at Escauaba, Mich.
WENDELL, Emory Brady, '85. Died July 30, 1904. at Detroit, Mich.
WENTZ, John Leisenring, M.E., '97. Died January 26, 1916 at Philadelphia.
WESSMAN, George Anthony, '04. Died Feb. 13, 1903 at Ithaca.
WEST, Albert Rood, '02. Died March 2, 1901 at Ithaca.
WHEELER, Merton Rone, M.E., '06. Died May 14, 1909 at Salt Lake City, Utah.
WHETSTONE, Walter, M.E., '93. Died April 25, 1901 at Philadelphia, Pa.
WHITE, Charles Miles, E., '91. Died Nov. 16, 1907 at Buffalo, N. Y.
WHITNEY, Alexander Barry, M.E., '98. Died May 14, 1900 at Augusta, Ga.
WHITTLE, Richard Page, M.M.E., '96. Died Oct. 29, 1897 at Denver, Colo.
WILKINS, Isaac C. G., M.E., '93. Died April 20, 1912 at Cold Spring, N. Y.
WILLIAMS, Albert Chadwick, M.E., '02. Died Sept. 19, 1906 at Phoenix, Ariz.
WILLIAMS, David, '72. Died Oct. 8, 1886 at Texas.
WILSON, Albert Lovett, '97. Died Feb. 4, 1908 at New York City.
WILSON, Fred Lewis, E., '92. Died Feb. 1903 at Elma, N. Y.
WINES, Arthur F., E., '99. Died Dec. 2, 1899 at Washington, D. C.
WINTERMUTE, Peter, E., '95. Died June 26, 1909 at New York City.
WITHERBEE, George Pease, E., '93. Died Aug. 28, 1893 at Port Henry, N. Y.
WOLCOTT, William Albert, M.E., '09. Died Feb. 16, 1910 at Jersey City, N. J.
WOOD, Edward Magill, E., '91. Died Aug. 26, 1901 at Niagara Falls, N. Y.
WOOD, William Reuben, '96. Died April 29, 1915 at Baltimore, Md.
WOODS, Arthur Taunatt, M.M.E., '90. Died Feb. 1893 at Chicago, Ill.
WOODWORTH, Benjamin Studley, '94. Died Feb. 22, 1912 at Fort Wayne, Ind.
WORK, John Stewart, '15. Died March 10, 1916 at Ithaca.
WRIGHT, Hubert Harris, '00. Died Dec. 18, 1913 at Cambridge, Md.
YOUNG, Ralph Goldsmith, E., '01. Died April 12, 1905 at Ithaca.
ZIMMER, Reinhart Albert, '15. Drowned in Cayuga Lake May, 17, 1913.

THE NEEDS OF THE ENGINEERING SCHOOLS AT CORNELL

(*Continued from page 243*)

tion I have made as regards endowment, other benefactors would doubtless come forward with gifts for buildings.

Cornell needs this endowment for its engineering schools. And its conspicuous and universally recognized services to engineering justify it in making the appeal. The $5,000,000 asked for the engineering schools is less than the sum donated by Colonel Payne to the medical school of Cornell University.

BOOK REVIEWS

Engineering of Power Plants, by Fernald and Orrok, ix + 586 pages, 6 x 9, 309 illustrations. N. Y., McGraw-Hill Book Company, 1916. Cloth, $4.00 net, postpaid.

In the preface of this work, the authors very correctly state that it "is not a treatise on power plants." It is designed to introduce the student to the commercial aspects of engineering enterprises. The volume is a collection of notes, with numerous tables of data, chiefly bearing on costs for the installation and operation of power apparatus and auxiliaries. Supplementing these are descriptions of the various types of each machine, with discussions of relative merits and various fields of application.

The data given are all several years old, so that they would be of limited value to the practicing engineer at the present time. For use with students for studying the principles of getting at costs, they will of course be very useful. Many of the tables could be presented more compactly and usefully as curves.

In the discussions one occasionally meets with obsolete or inexact statements, and inconsistent use of symbols; but these cases are rare, and the discussions should be helpful to a beginner. The illustrations are numerous and excellent, though sometimes removed by several pages from the relevant text, with no references given.

There are valuable chapters on topics of great importance, such as foundations, piping, handling machinery for coal and ash, and variable load economy and the cost of power. These should serve to bring before the student some of the problems of power generation which cannot be solved by theoretical study.

The book is characterized by an abruptness of style which makes it resemble outline notes rather than a unified volume. This, however, is not objectionable, and makes it possible to present a large amount of material in the space utilized.

Throughout the book it is assumed that the reader is familiar with the principles of operation of the various pieces of apparatus, and no explanations appear. When formulas are introduced, their derivation is not indicated. For this reason, the book could hardly be used as a text except with advanced students, unless it were supplemented by lectures or another text. For use with advanced students, the volume should serve as a combination of text and handbook of cost data, on the basis of which could be developed an excellent course in engineering practice and judgment in the application of theory to every-day problems. It is regrettable that the defects of the book were not eliminated before publication, and that the data are, for the most part, so old.

C. H. B.

Physical Laboratory Experiments for Engineering Students, by Samuel Sheldon, Ph.D., D.Sc., and Erich Hausmann, E.E., Sc.D. 8" x 5½". 134 pages including Tables of Physical Constants and Indexes; 40 illustrations. Publishers: D. Van

(*Continued on page 12ad*)

OCTOBER, 1916 TWENTY CENTS

THE SIBLEY JOURNAL OF ENGINEERING

CORNELL UNIVERSITY

VOL. XXXI NO. 1

The Sibley Journal of Engineering

SIBLEY COLLEGE, CORNELL UNIVERSITY

Published by

THE SIBLEY JOURNAL OF ENGINEERING, Inc.

Ithaca, N. Y.

FOUNDED 1885 — INCORPORATED 1916

JUSTIN F. WAIT - - - - *President*
WILLIAM N. BARNARD - - - *Vice-President*
EARL G. HENDERSON - - *Secretary-Treasurer*
CLARENCE A. PEIRCE - - *Second Vice-President*

THE PUBLISHERS' ANNOUNCEMENT

SUBSCRIPTION PRICES:

United States, Mexico and Canada, $2.00 a year — **Foreign, $2.25 a year; payable in advance**

Remit by postoffice or express money orders, bank checks, drafts or registered letters made payable to THE SIBLEY JOURNAL OF ENGINEERING, INC. Money in letters at sender's risk. Should a subscriber desire to discontinue his subscription, notice to that effect should be sent in before its expiration. Otherwise it is assumed that a continuance of the subscription is desired.

We are glad to extend the privilege to our contemporaries of republishing extracts from THE JOURNAL provided that we are notified of such intention and that proper credit be given.

An index will be published as a part of September number of each year.

ADVERTISING:

The rates for advertising will be quoted on application. Copy should be in the hands of the publishers by the 7th of the month preceding publication.

THE SIBLEY JOURNAL OF ENGINEERING, INC.
ITHACA, N. Y.

TABLE OF CONTENTS FOR OCTOBER, 1916

EDITORIALS

ARTICLES

ADVERTISERS


KEYSTONE
ABC
SECOND
EDITION
The Grooving of Bearings and their care
THE
KEYSTONE
METHOD

Norman Graves Reinicker, '11, was married Sept. 20, 1916 to Miss Nathalie Arthur of Westfield, New Brunswick. Mr. and Mrs. Reinicker will be at home after December 1 at the Poincianna, 434 W. 120 St., New York City.

F. D. Lindquist, '15, is engaged with the Nitrogen Products Co., of Saltville, Va. The company is doing some very important work in the development of fixation of atmospheric nitrogen.

George Filbert, '12, formerly with the New York office of the Diehl Mfg. Co., has been made the purchasing agent of the company and is now at the factory in Elizabeth, N. J.

John Atkinson, '13, was married to Miss Edith E. Stringer at Buffalo, N. Y., on June 22. They are now at home at 245 Barton St., Buffalo, N. Y.

Karl G. Kaffenberger, '13, is with the 7th New York Infantry at Pharr, Texas. He was married to Miss Edith D. Millard of Syracuse, at Buffalo on June 24. The ceremony was advanced on account of his expected departure for the border.

Ambrose Ryder, '13, was married to Miss Viola Foshay Hyatt, at Carmel, N. Y., on July 6. Mr. and Mrs. Ryder will make their home in St. Louis.

Laurence C. Bowes, '13, has left the employment of Swift & Co., and is now with the Chicago, Rock Island, & Pacific Railroad Co. as inspector of stationary boiler plants. His work takes him over the entire Rock Island System, but his home address remains the same.

G. W. Zink, '12, of Bridgeport, Conn., announces the birth of a daughter, Mary Stillman, born July 21.

J. M. Benore, '16, has taken a position in the time study department of the Smith Premier Typewriter Co., Syracuse, N. Y. His address is Box 524, Y.M.C.A. Syracuse, N. Y.

Lenox R. Lohr, '16, has been notified by the War Department of the United States that as the honor graduate of Cornell University for 1916 he is eligible as such for an appointment to the United States Army in the grade of second lieutenant. Mr. Lohr has accepted the appointment and will join the army October 15, 1916. While at Cornell, Lohr became quite proficient in automobile engineering work and was the president of the student branch of the S. A. E. He contributes for this issue of the SIBLEY JOURNAL the up-to-date article on "Carburetors," a subject on which he did considerable research work this summer.

EMPLOYMENT NOTES

216. Mr. H. N. Reeves, Supervisor of Supplies and Motor Vehicles, Bell Telephone Co., of Pa., 1230 Arch St., Philadelphia, wants M.E. to develop as mechanical expert on motor vehicles (autos, trucks, special apparatus, tests, etc.).

219.* An electric alloy concern near New York City wants young man to take charge of engineering depart-

*Address applications to this number, care of Sibley Employment Bureau, for forwarding.

ment and testing laboratory, involving knowledge of metallurgy and electrical resistance properties.

221.* There is an opening in Brooklyn for man on laboratory work connected with gasoline motors, starting, lighting and ignition apparatus, carburetors, electric dynamometers, automobile motors, etc.

Also this concern has an opening for a draftsman.

222. Mr. A. S. Loizeaux, Electrical Engineer, Consolidated Gas Electric Light & Power Co., Baltimore, Md., has openings ($12 per week) in course affording opportunity for learning central station business, including both the technical and commercial sides. The course follows a fixed schedule under department heads and is completed in about forty-two weeks.

223. The Miller Rubber Co., Planning Dept., Akron, O., wants man to systematize the mechanical design and inspection of one of their products. Previous designing experience not essential, but useful. Salary $75 up per month according to proven qualifications.

224. Mr. George W. Welker, United Natural Gas Co., 308 Seneca St., Oil City, Pa., may have opening for man either for drafting or for field work.

225. Mr. C. E. Curtis, Superintendent of Buildings and Grounds, Cornell University, wants man who has had one or more year's experience with steam power plant work, and preferably some electrical experience, for efficiency and similar work.

226. W. H. Donley, Sec. Dept. of Cadet Engineering, Philadelphia Electric Co., Tenth and Chestnut Sts., Philadelphia, Pa., has openings in two year Cadet Course for technical graduates, starting at $60 per month.

227. Mr. W. A. Jones, Proposition Dept., Babcock & Wilcox Co., Bayonne, N. J., has opening for men to make layouts of boiler plants and estimates of cost. Men with one or two years' experience preferred.

228. Prof. F. G. Bænder, University of Arkansas, Fayetteville, Ark., wants one man to teach foundry and wood work. Salary $1000 to $1200 depending on qualifications. Also man to teach forge and machine work.

229. Debevoise-Anderson Co., 56 Liberty St., New York City, wants recent graduate. (Pig iron, ore, coke, coal, limestone.)

231. N. Y. State Civil Service No. 198 junior assistant, Engineering Departments, ($901–$1200). Civil Engineering mostly. Obtain blanks from Albany before October 23.

232.* Chief Engineer is wanted for concern in Middle West. Must have had experience in tempering tool steel and case hardening small parts for sewing machines, bicycles, motorcycles, etc. Also it is preferred that he have had experience in manufacturing such parts and in making tools for same.

233. J. K. Williamson, '06, Pres. Porcupine Boiler Co., Bridgeport, Conn., wants recent C.E. or M.E. for designing plate and structural work. Experience unnecessary.

234. Mr. A. S. Garrett, Pres. American Water Softener Co., 1011 Chestnut St., Philadelphia, wants young man as draftsman with possibility of work along other lines later.

235.* A plate glass concern near Pittsburgh wants recent graduate to learn plate glass manufacturing, and another man for window glass manufacturing. Excellent opportunities ahead for both men.

236. U. S. Civil Service Exam. 1322 for Junior Drainage Engineer ($960–$1440). Nov. 8, 1916. Apply to Commission, Washington, D. C., for form 1312.

237. Mr. T. S. Hammond, Whiting Foundry Equipment Co., Harvey, Ill., wants graduate of "business course" to learn business end of manufacturing, including stockkeeping, purchasing, cost accounting, etc.

238. Mr. J. W. Duffins, Employment Agent, Burro, Mountain Copper Co., Tyron, New Mexico, wants young E.E. for position in a large concern, offering opportunity to acquire very varied experience.

A. Wood, '91, General Manager of The Niles Tool Works Company, Hamilton, Ohio, has openings for a few men who have had experience in heavy machine tool designing.

---

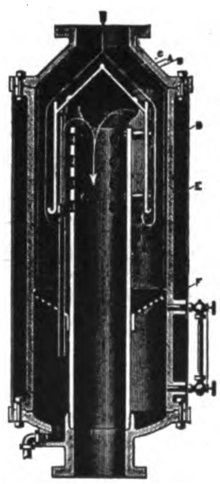
*Address applications to this number, care of Sibley Employment Bureau, for forwarding.

Sweet's

Steam and Oil Separators

Operation

THE accumulated moisture around the walls of the steam pipe is caught by the upper edge of cone A and carried down back of a lining to the water chamber. The current of steam entering the Separator impinges upon the conical surface composed of solid plate C covered with sieve B, through which water may freely pass, but from which it cannot readily escape. Passing through the sieve and depositing on the solid surface of the cone C this water is carried by conductors to the water chamber. By means of the cone the column of steam is changed to an annular ring, which is comparatively thin, even while the full area of the pipe is maintained. The steam upon the outside of this ring comes in contact with the lining of the shell, which has a sieve of the same character, as at B, and which catches and entrains any water which may be contained in that portion of the current. There is also provided a lip at lower edge of inverted cup, which leads all the water that may adhere to its surface down through the conductors to the water chamber. The current of steam passes through the passage indicated by white lines, and is subjected to a whip-snapping action, which will throw off any moisture that has not been caught by the surface over which it has passed. The diaphragm F prevents the steam from picking any water out of the water chamber.



Made in all styles **Vertical Style** *Send for catalog*

DIRECT SEPARATOR COMPANY
Corner Fayette and Geddes Streets
SYRACUSE, N. Y.

UNIVERSITY NOTES AND PERSONALS

In the University Notes of the July issue there appeared several misleading statements with regard to the aviation school at Cornell. These were caused by the earliness of the information. At the aviation school here there are enrolled about two hundred men. They are divided into eight squadrons of about twenty-five men each. A squadron comes into the school each week and is trained as a unit for the entire eight weeks that it remains here.

The first three weeks that it is here are spent in drill, while during the last five weeks one hour a day is devoted to drill, and the rest of the time is put in the lecture room and in laboratories. No flying instruction is given at Cornell. The aviators who have not already had the experience in this line get it either at Mt. Clemens, Mich., or at Fairfield, as soon as they have finished the course here.

Several Sibley men are in attendance at this school, and among them are: W. C. Suiter, '13, R. A. Anderson, '16, J. A. Meissner, '18, H. Raynolds, '18, and P. C. Wanser, '18.

L. A. Wilson, '09, is at present engaged as instructor in charge of engine instruction in the Cadet School of Military Aeronautics at the University of Illinois, Urbana, Ill.

Gordon D. Robinson, '14, is in the Westinghouse Professor's course this summer.

Charles E. Oakes, M.M.E., '17, is at present connected with the Bureau of Standards as Assistant Electrical Engineer.

BOOK REVIEW

(*Continued from page 12ad*)

"When great accuracy is required, correction factors must be added to the above expression.

"This formula has been of much service in determining the charge on an electron.

"(G. G. Stokes, Mathematical and Physical Papers, Vol. III, p. 59. See also Campbell, Modern Electrical Theory, p. 91.)"

The entire field of Physics and a part of Physical Chemistry are treated in this way, making a volume not only of very great value as a reference work, but, on account of the logical arrangement of subject matter, a convenient outline for study or review for the student. It is worthy of a place on the desk of every physicist, engineer, and chemist.

It is to be regretted that the author did not further enhance the value of the volume by the addition of a set of tables giving some of the more important physical and chemical constants. Perhaps this feature can be incorporated in later editions. F. K. R.

ENGINEERING ABSTRACTS

(*Continued from page 22ad*)

Another type of blowing engine, combining some of the advantages of both of the types described above, is the vertical-horizontal machine. Usually in this case the air cylinders are vertical and the steam cylinders horizontal. These engines are made both simple and compound.

The leading manufacturers of blowing engines make all of the standard forms, which are usually designed to deliver from 40,000 to 60,000 cu. ft. of air per minute. In the case of compound engines the high pressure cylinders usually run from 40 to 48 in. in diameter and the low pressure from 78 to 84 in. The air cylinders corresponding to the above may be from 84 to 96 in. in diameter. Engines of these dimensions usually have a stroke of 60 to 66 in. and run at speeds not exceeding about 50 r. p. m. with the older type of air valves.

The cylinders are provided with inlet and discharge valves at both ends; these usually being placed in the cylinder heads.

Automatic plate valves are now coming into general use, and have resulted in simplifying the valve gear and making it possible to nearly double the speed as compared with some of the older types.

The fact that the blast furnace gas is adapted for use in direct combustion engines, together with the low efficiency of steam equipment, has led to the use of gas engines for furnishing the blast in a large number of large plants. Engines of this type lack the flexibility of steam engines, under varying conditions of operation, having little or no overload capacity. This has usually been provided for by operating the engines at full load and meeting emergencies by the use of reserve units. Some of the latest engines of this type are equipped with special devices for regulating the output according to the load requirements.

One of the latest developments in the line of blowing machinery for blast furnace work is the turbo or centrifugal blower, usually driven by a direct connected steam turbine. There are several different makes of these machines, all operating upon the same general principle, although differing somewhat in detail. In design they are similar to a hydraulic turbine pump with such changes as are necessary to adapt them to the handling of air. They are made in different sizes up to a capacity of 50,000 cubic feet or more of air per minute at a maximum pressure of 30 lb. per sq. in. Among the chief advantages are simplicity of construction and a steady discharge of air without pulsations.

C. H. B.

PERSONAL

Douglas Bunting, M.E., '94, of the Lehigh and Wilkes-Barre Coal Company, Wilkes-Barre, Pa., has been appointed a member of a committee on mining equipment of the U. S. Bureau of Mines, representing the American Society of Mechanical Engineers.

PRESS OF W. F. HUMPHREY, GENEVA, N. Y.